MACHINE DESIGN

March 1951

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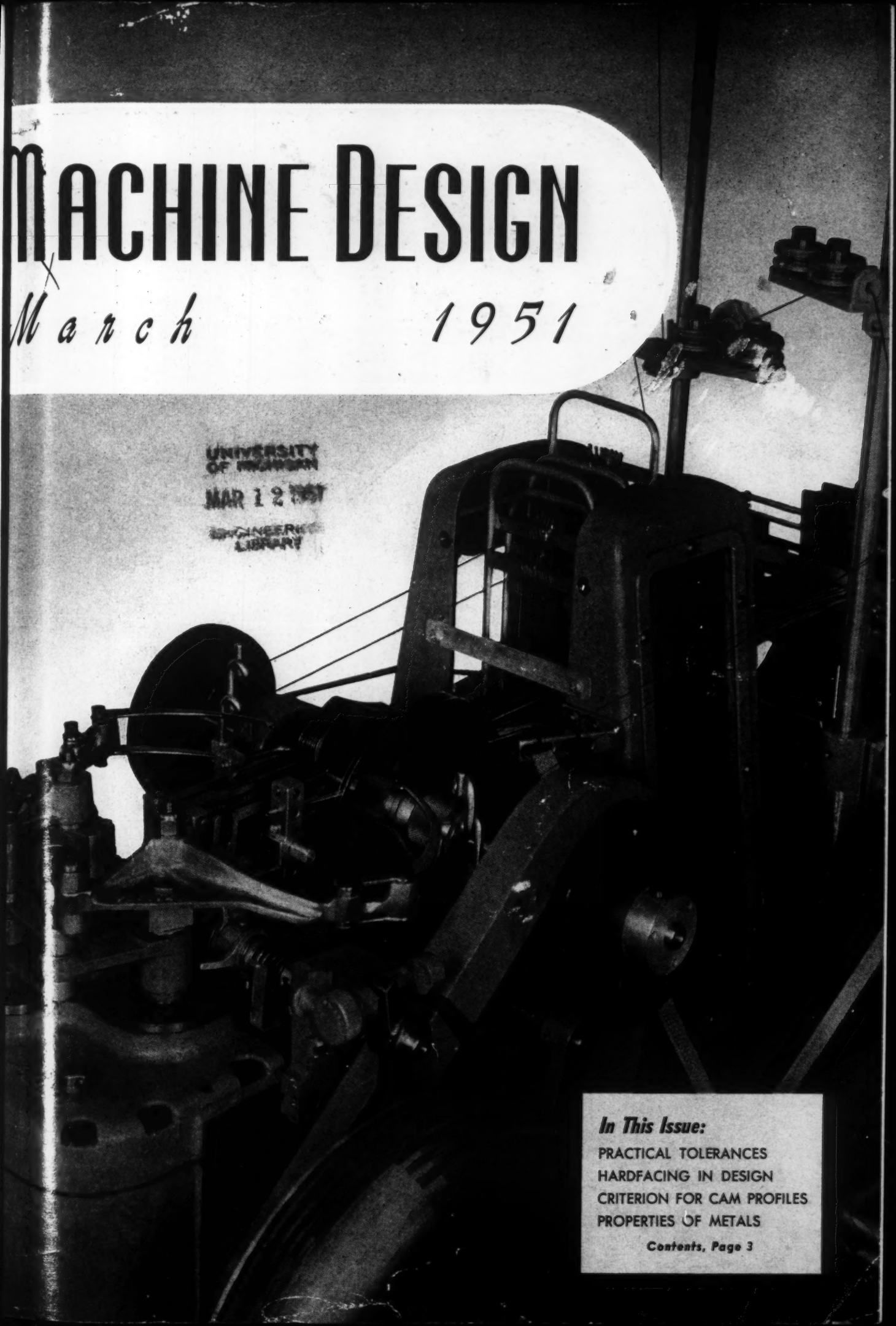

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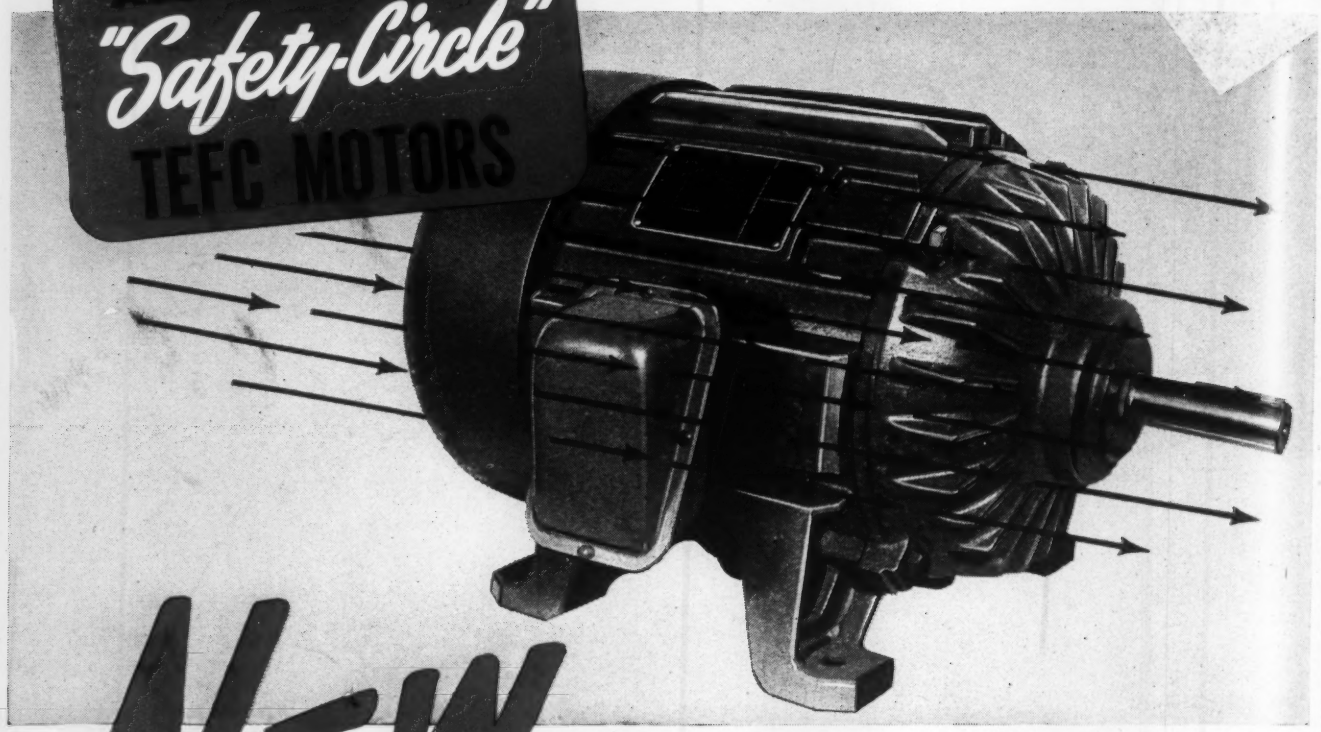

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MACHINE DESIGN

THE PROFESSIONAL JOURNAL FOR ENGINEERS AND DESIGNERS

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CCA SBPE NBP

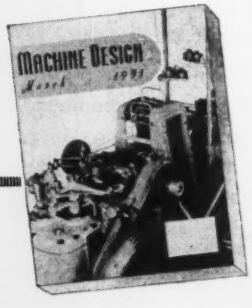
Over the Board

Customer Complaints

Department stores have no monopoly on customer complaints. Our readers, too, have their troubles with users of their machines. Not many, however, run into quite as unreasonable an attitude as did one of our good readers who is a machine tool design engineer. His company kept getting bitter complaints from a research laboratory machine shop that the dividing head supplied with one of their machines was hopelessly inaccurate. So insistent and sarcastic were the complaints that the part in question was finally brought back to the plant for checking. Although the head had been in service for ten years it was found to possess an accuracy well within the limits adhered to in present production. The truth of the matter was that the user's method of checking was much less accurate than the part itself. But the payoff came when a check of the records revealed that the entire machine had been donated by the manufacturer, brand new, to the research outfit, which was connected with an institution of higher learning.

This Month's Cover

In selecting illustrations for our covers we try to convey in a pleasing picture something of the flavor and atmosphere of machine design. We also try to show, in successive months, designs which are typical of the various branches of machinery building. For instance, in January we showed a dictating machine and in February, modern aircraft. This month we salute the textile machinery designers by depicting on the cover the "guts" of a modern, high-speed narrow-fabric needle loom. Built by Crompton and Knowles Loom Works, the machine is a perfect example of engineering design for function.



SBME

Perhaps you have wondered about the three insignia appearing at the foot of the left-hand column of Page 3 in MACHINE DESIGN. These represent our affiliations with organizations in the publishing field. In later issues we plan to tell you about the CCA and the NBP but right now we'd like to comment on the middle insignia. If your eyesight is good and our printer has kept the engraving clean you may be able to distinguish the words Society of Business Magazine Editors. This is an organization of more than one hundred editors of leading trade and technical journals published in the United States.

Principal activity of the society consists of meeting in Washington about once every two months. There the editors meet in conference with government officials, congressmen and others from the President on down, listen to talks and briefings on matters of current importance to business and to the nation. Information gained from these meetings often represents a preview of things to come and enables the editors to plan ahead and to interpret trends.

Fractures

So many readers have asked us for extra copies of Charles Lipson's eight-part series of articles on "Why Machine Parts Fail" that we have published the entire set as a 42-page reprint. Priced at one dollar each the reprints may be obtained by writing to Machine Design Book Dep't., Penton Building, Cleveland 13, Ohio.

A Pledge

Business magazine editors have taken a lead which might well be followed by newspaper editors. At the recent business mobilization dinner in Washington, members of the SBME (see adjacent column) adopted this resolution:

Whereas it is now clear that we who believe in the freedom of mankind are involved in a great world struggle with those who do not, and

Whereas this struggle may be the last opportunity to prove that free labor led by free management can produce more than slave labor under dictators

Therefore be it resolved that we, who enjoy individual freedom as independent editors of America's business magazines, do hereby pledge ourselves as editors to arouse and support the kind of productive effort that will demonstrate the omnipotent power of the free spirit.

Next Month's Issue

Watch for the April "Drives and Controls" issue. An impressive line-up of feature articles on mechanical, electrical, hydraulic, and pneumatic drives and controls is being assembled. Our art editor, Frank Burgess, has designed a colorful layout scheme and the entire main editorial section will constitute an attractive package which you'll want to file for reference. Extra copies of this section will be available without charge.

. . . at the "Business" End of Business Machines

Much of your morning's mail probably was directed to your desk with the help of ENDURO Stainless Steel. For, at the "business" end of high-speed addressing machines, embossed information plates engage inked ribbons through windows of ENDURO ribbon guards. Here, ENDURO resists ink-caused corrosion, resists the abrasive action of the moving ribbon, resists deformation, stays "springy."

On the same machines, ENDURO is used for "lister spacing bands"—punched ribbons which control the precise listing of tabular data at speeds as high as 6000 figures a minute. Where out-of-round holes would cause misalignment, ENDURO resists wear.

What jobs will ENDURO be given next? It's already doing so many so well.

Locomotives whistle its presence as stainless steel passenger cars flash by. Jet planes roar its contribution to their blazing speed. The absolute purity of your foods, drugs and beverages is a testimonial to its sanitation. Coal mine shaker screens testify to its strength and toughness. The list is endless . . . and growing.

This "Thrifty Metal of 10,000 Uses" has a place in your metal products and in your manufacturing processes. Republic metallurgists will be happy to show you how to apply it, so that its remarkably long service life and freedom from maintenance can help conserve other critical materials. Their service is confidential and without cost. Just write:

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TOPICS

ANTISKID DEVICES of two types are being used on Air Force bombers. One is an adaptation of the Westinghouse Decelostat. Its principle of operation is based on the relation of deceleration rates of the airplane landing wheel and of an energy wheel. The other device is the Hytrol system developed by Boeing. It employs a flywheel mechanism to detect sudden changes in wheel speed and to energize a solenoid valve that controls brake pressure.

J-40 JET ENGINE produced by Westinghouse develops thrust equal to 14,000 hp and weighs less than 3,000 pounds. Addition of an afterburner is expected to increase the thrust almost two times.

MOLYBDENUM DISULFIDE has been found effective in inhibiting fretting corrosion which occurs when closely fitting metal surfaces have slight relative motion, as in assemblies subjected to vibration. Oddly enough, according to tests reported in NACA Technical Note 2180, specimens with a baked-on mixture of molybdenum disulfide and corn syrup showed greater freedom from fretting corrosion than any other mixtures containing the compound.

NEW CAMERA employing an electrostatic-electrophotographic process produces finished pictures in two minutes. Light is recorded as an invisible electrical image on a selenium-coated 4 by 5-inch metal plate which is first sensitized by an electrical charge. Finely ground powder dusted across the plate is held by the charge. The powder image is then transferred to paper or other material coated with an adhesive. Development of the camera has been sponsored by the Signal Corps.

CORROSIVE EFFECTS can be measured by a new technique developed by Armour Research Foundation under NACA sponsorship. Similar to television scanning, the method can be used for detection and analysis of corrosion phenomena. The laboratory sample, a metal cylinder, is dipped in some corrosive solution and rotated several hundred times per minute. Consisting of 11 silver wires in a plastic arm, a stationary probe electrode is placed about 0.02-inch away from the submerged sample to pick up the minute electrical currents caused by corrosion. The currents are amplified and viewed on an oscilloscope screen or recorded photographically.

IGNITION CABLE developed by GM's Packard Electric Division withstands temperatures up to 400 F. Intended for continuous service at the high temperatures found forward of the fire wall in aircraft engine compartments, the cable is insulated by laminations of glass and Teflon, a new resin.

ALUMINUM is finding extensive use in Arctic regions by the Armed Forces because it is stronger in subzero weather than at room temperature.

WIDTH GAGE of a noncontact type has been developed by General Electric for continuous measurement of metal in hot-strip mills. Installed above the strip are two detectors mounted on a precision lead screw and set apart a distance equal to the desired strip width. An optical image of each hot strip edge is converted into an electric-charge pattern by a phototube. Actual deviation of the strip from the width set by remote control is shown in fractions of an inch by an indicator.

BONDING RUBBER TO METAL by a new method known as the Redux process has been reported by the National Rubber Bureau. Obviating the preliminary brass plating of the metal heretofore required, the Redux process involves treatment of the rubber surface with sulfuric acid, application of a resin to the washed and dried rubber and to the metal, and clamping of the two parts together under moderate temperature and pressure.

HIGH DENSITY is the feature of a new metal known as Hevimet manufactured by Carboloy Co. Denser than lead by 50 per cent, it is applicable for such parts as balance weights on crankshafts, gyroscopes, variable-pitch propellers, etc. Also, it is used in screens to resist the penetration of radio-active rays.

MACHINE DESIGN
A PENTON PUBLICATION

Allocations—A Personal Problem

OUT of 168 hours in every week we spend some 40 hours actually on the job. Add to that perhaps 88 hours devoted to certain occupations essential to living: eating, sleeping, dressing, traveling to and from work, etc. That leaves 40 hours, roughly as many hours as we spend at work, to use more or less as we please. Enough time to do another whole job—on ourselves.

To do an effective job, how shall we allocate those 40 hours? Few will dispute the need to devote adequate time to each of three areas of personal life: professional development, social life, and recreation. Professionally, we need time at least to attend meetings of our professional societies and to read our professional publications. Socially, we should engage in activities in the company of our fellow men, including participation in civic and religious affairs. Recreation is no less essential to our physical and mental well-being, but for some time it has threatened to absorb an unreasonable proportion of our personal time—and television has intensified the problem.

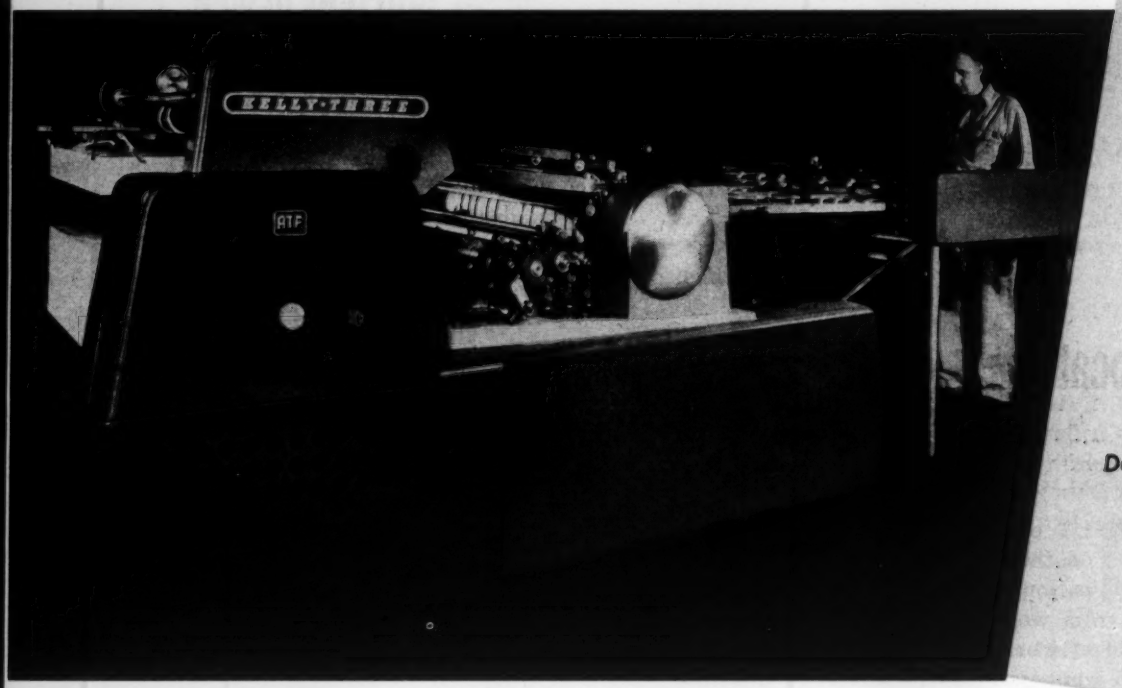
Now more than ever before it behooves us to weigh most carefully the value of our time, lest we find ourselves short-changing the more creative forms of recreation, social life and professional development in favor of activities which offer less value in developing or even relaxing mind and body.

The problem is no different in principle from the allocation of materials. Although we speak of shortages, actually it is the unprecedented demand that has disturbed the balance—there is as much material being produced as ever. So it is with time. What we do with our own time is strictly our own affair; but by the same token our development as effective citizens and engineers will be in direct proportion to our wisdom in allocating that time.

Colin Carmichael

EDITOR

Fig. 1—Kelly Three press shown from gear side. Design modifications provide for higher speed, larger capacity and improved appearance



Design or New

By Carl F. Keas

Designer, Engineering Department
American Type Founders Inc.
Elizabeth, N. J.

WHETHER to design and develop a completely new machine or to redesign an existing model is a frequent and troublesome management problem. Because of the necessity for increased capacity and speed and a desire to improve the appearance of a printing press, American Type Founders Inc. was faced with this choice. Consideration of the excessive cost involved and the time required for development of a new design, compared with the excellent performance of the existing press, led to the decision that modification was the wise thing to do at this particular time. This was especially true since it permitted getting into the field with a new product at the earliest possible date. New Kelly Three and old No. 2 presses are shown, *Figs.* 1 and 2.

MECHANICAL DESIGN: The engineering department's first task was to alter the dimensional characteristics of the cylinder to accommodate a sheet size of 25 x 37 inches, 1 inch wider and 2 inches longer than the previous size. The existing cylinder measured 35½ inches between its bearers, each bearer being 1¾ inches wide. To increase the length of the entire cylinder, thereby allowing the bearers to be moved farther apart, meant the press side frames would be spread farther apart, entailing a multitude of changes that were undesirable. Instead, each cylinder bearer was narrowed to half its width by undercutting the inside half to the same diameter as the body of the cylinder, as shown in *Fig.* 3. This resulted in the greater distance of 37¼ inches between cylinder bearers without making any other alterations to accommodate mounting the cylinder.

The cylinder pattern was recored to allow for printing 25 inches circumferentially. To match the cylinder bearers, the bearers on the bed were reduced to ⅞-inch in width from their original 1¾ inches. This doubled the unit bearing load on the bearers. For this reason, the material was changed from cast iron to heat-treated alloy steel. The cylinder bearers are hardened and drawn to Rockwell 45 C, and the bed bearers are drawn to a hardness of Rockwell 40 C. The latter are softer to take the greater amount of wear. They are easy to remove from the bed for replacement in case of wear, whereas the cylinder bearers' removal would constitute a major tear-down.

Bearer Redesign Simplifies Installation

To maintain the maximum bearing surface between the cylinder bearers and bed bearers, drilling and counterboring the bed bearers from the top side, as was done in the old press, was abandoned. Instead, clearance holes are drilled in the bed and hexagon head cap screws are brought through from the bottom into blind tapped holes in the bottom of the bearers, *Fig.* 3. This leaves an uninterrupted bearing surface on the top side of the bed bearers.

In order to handle the 25-inch dimension on the

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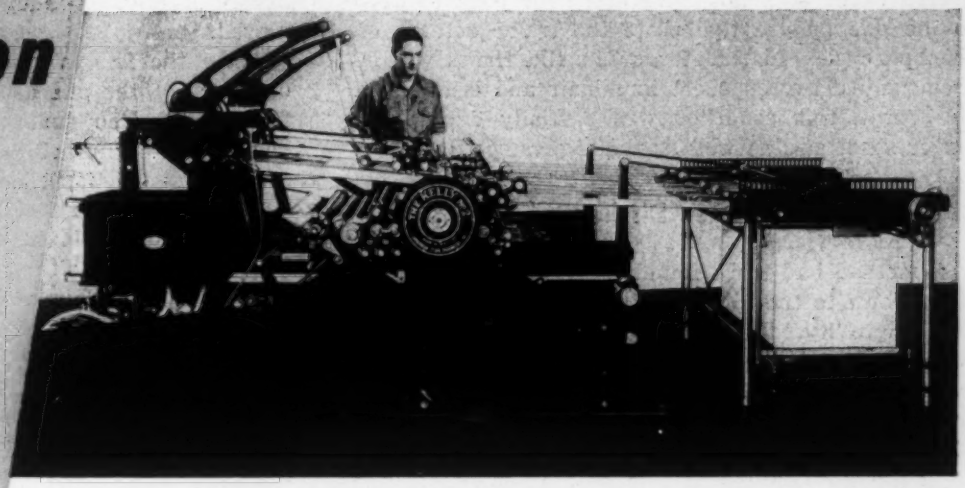
w simple changes crease capacity printing press

Fig. 2—Old Kelly No. 2 press which was redesigned rather than to develop an entirely new press



bed, the printing form had to be extended an extra inch at the delivery end. The bed was long enough to handle this extra inch but the form rollers, of which there are three located between the ink fountain and the impression cylinder, were positioned in such a manner that they would not do a complete job of inking the larger form. Investigation showed the form rolls and the entire inking mechanism could be moved closer to the delivery end, thereby effecting complete coverage when the bed traverses its stroke to the feeder end of the press.

Inasmuch as the longitudinal forces created by the reciprocating bed are a controlling factor in the maximum speed attainable, it seemed wise to concentrate on reducing the beds weight before attempting to raise the speed from the previous 3000 to the specified 3500 impressions per hour. The natural thing to do was to discard the cast iron bed for a welded steel bed. In designing the steel bed, the highest possible rigidity had to be maintained to prevent any appreciable flexing under the impression load of the cylinder while printing.

Since the total impression load between the bed and the cylinder is 9000 pounds, any structural weakness in the bed would cause trouble. In order to attain the necessary strength in a welded bed without running into serious warpage, it was decided to rib the bed on a parallel pattern crosswise of the press, or in line with the shaft of the cylinder. For maximum possible stiffness, these ribs are fabricated from formed steel channels, the legs of the channel being electric-arc welded by a continuous bead to the underside of the top plate, which forms the surface of the type bed. These channels are further reinforced by welding gussets between them at regular intervals. Besides the gussets, four bars are welded lengthwise of the bed across the entire bottom, tying the bases of the channel ribs together, and forming ways upon which the type bed rolls on its four tracks.

To secure additional strength and wear resistance, the top plate is an abrasion-resistant steel, and the bottom four ways are a medium high-carbon steel for longer bearing life. The final result is a welded steel bed of sufficient rigidity weighing 285 pounds. The former cast iron bed weighed 420 pounds. This 135-pound reduction in weight, being in the oscillating portion of the press, definitely contributes to making the desired higher speed possible.

New Gripper Shaft Prevents Windup

To counteract the effects of higher speeds, and to make a more sturdy machine, all the frames and cross braces are solid cast iron, *Fig.* 4, whereas the cast iron frames previously used were cored. All told, the dead weight of the press is increased 1400 pounds, resulting in considerably greater stability.

When operating at the new higher speed, the old gripper shaft showed a tendency to wind up and unwind during each cycle, thereby making hairline register difficult. Considering the fact the grippers open and close through an arc of approximately 125 degrees, actuated by a tumbler type of cam on the overhanging end of the gripper shaft, *Fig.* 5, it is evident that this shaft would have some distortion at high speeds. Consequently, the shaft was enlarged from 0.875-inch diameter to 1.0-inch diameter. It was then mounted on needle bearings, *Fig.* 5, instead

of bushings, to reduce the bearing friction.

The higher speeds are also taken into consideration at the delivery pile. Because of the higher speed of the oscillating delivery tape frames, the delivered sheet does not have sufficient time to drop to the pile by gravity before the frame returns on the next cycle. Instead, it would strike the tail of the previously delivered sheet in midair and crumple it. Of course, this condition was partially due to the larger sheet size as well as the higher speed.

Air Blast Settles Discharged Sheet

A method had to be found to force the tail of the sheet down to the pile faster than it would normally fall by gravity. An intermittent blast of air seemed to be the most logical way to do it, so a blast pipe was installed across the oscillating tape frame just to the rear of the tape pulleys where the sheet is run off the tapes. Instead of piping into the air lines from the air pump, which is at the far end of the press under the feed pile, it was found that a blast could be bled from the air cylinders, *Fig.* 4, which normally function as cushions for the bed at the delivery end of its stroke. It developed that the type bed pistons struck into these cylinders at just the proper time for the blast to be effective.

These design modifications produced all the new mechanical features desired for the change-over. However, alterations and additions necessary for improved appearance were yet to be accomplished.

STYLING: To style the press frames and other component parts in line with modern trends would have defeated the desire to accomplish the change-over in the least possible time. Such an undertaking undoubtedly would have led into an almost unlimited number of mechanical changes for the sole purpose of appearance. The final decision was to fabricate sheet steel guards and fasten them to the press frames with studs and brackets. To insure proper styling, an industrial designing firm was employed.

After the final sketches were presented, working drawings of the guards were made so they could be fabricated. The quantity of production would not permit the manufacture of expensive blanking and forming dies. Consequently, all designs had to be such that they could be fabricated by hand blanking, use of the press brake and bench work. They also had to be proper size sections so they would be reasonably easy to handle while attaching or detaching from the press in the event that service might be required at a later date.

The most suitable material proved to be No. 16 gage (0.0598) stretcher-leveled cold-rolled sheet. This gage is sufficiently heavy to give a rigid guard, yet light enough for ease in fabrication. The stretcher-leveled sheet was used because the style of the guards is such that the large flat surfaces might have a tendency to show waviness or buckling in the finished product.

Lift Brackets Removed for Appearance

In restyling, the only solution for the conveyor frame lift brackets, which towered above the press with hoisting cables dangling down to the conveyor frame, *Fig.* 2, seemed to be their complete removal and incorporation of a new method for raising the conveyor frame. This was accomplished by mounting two bearing brackets on the same pads from which the conveyor frame lift brackets were removed.

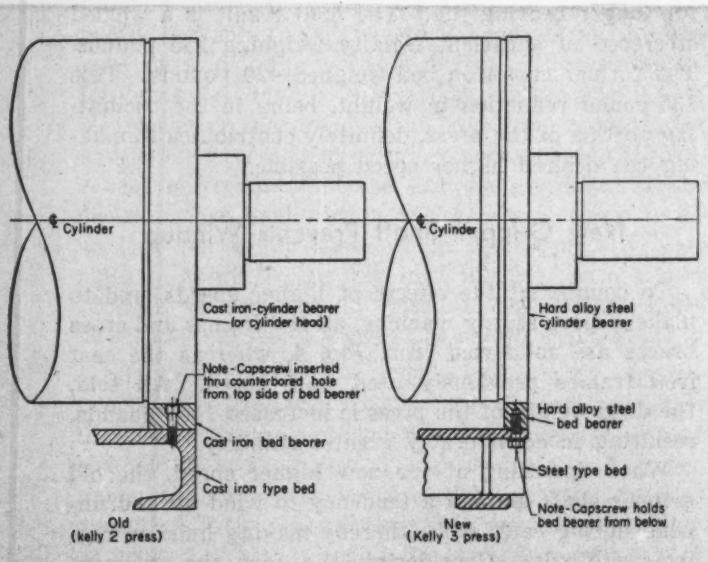

Cylinder
Cast iron-cylinder bearer (or cylinder head)
Note - Capscrew inserted thru counterbored hole from top side of bed bearer
Cast iron bed bearer
Cast iron type bed
Old (kelly 2 press)
Cylinder
Hard alloy steel cylinder bearer
Hard alloy steel bed bearer
Steel type bed
Note - Capscrew holds bed bearer from below
New (Kelly 3 press)

Fig. 3—Above—Old style cylinder and bed bearer arrangement compared with new design permitting use of longer cylinder in the same frame

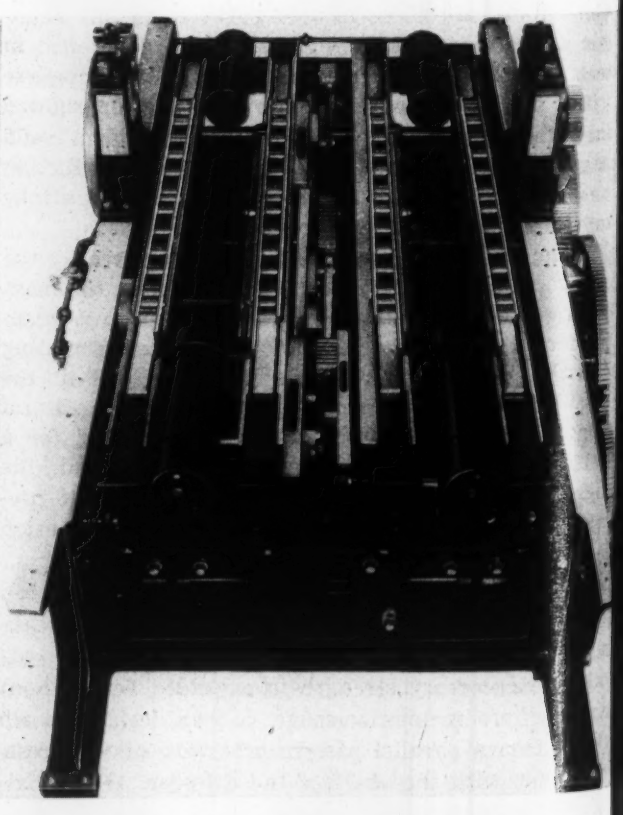
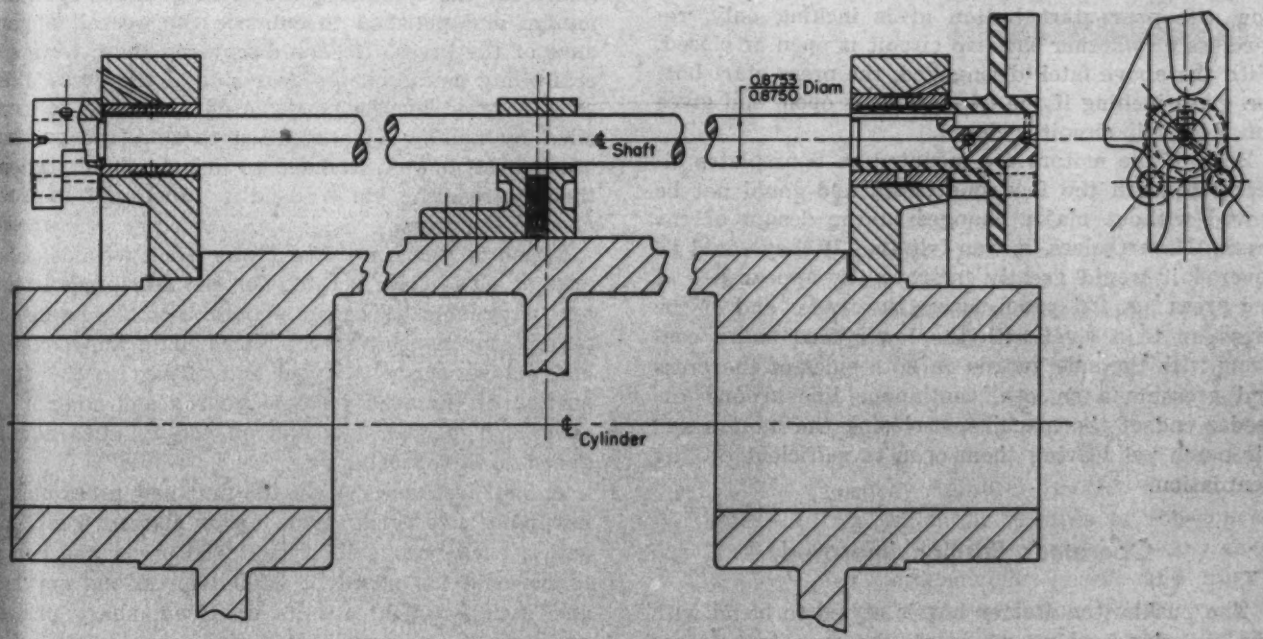


Fig. 4—Right—Bed frame of Kelly Three showing cast frames, cylinder bearers and air cylinders

Then by means of a pinion and gear reduction to a small roller chain sprocket, connected to the conveyor frame trunnion bracket, the frame is raised with a crank and clutch assembly, making it impossible for the conveyor frame to be accidentally dropped when in the up position.

The motor control box, which is attached to the feeder frame on the gear side of the press, presented another problem. So far as operation of the press is concerned, it already was in the most logical position. Removal was ruled out. At the same time, a specially designed control box for small quantity production would prove troublesome and expensive. It was decided to keep the standard box and to cover it with a drop hood incorporated as part of the new guards. The speed control knob and reset button protrude through openings in this hood and are styled to blend harmoniously with the overall appearance of the new guards. In the guard just below the hood, three rows of round holes provide ventilation for the control box.

The press is driven through V-belts by a 5-horsepower variable-speed motor and control. The air pump, which supplies suction and blast to control



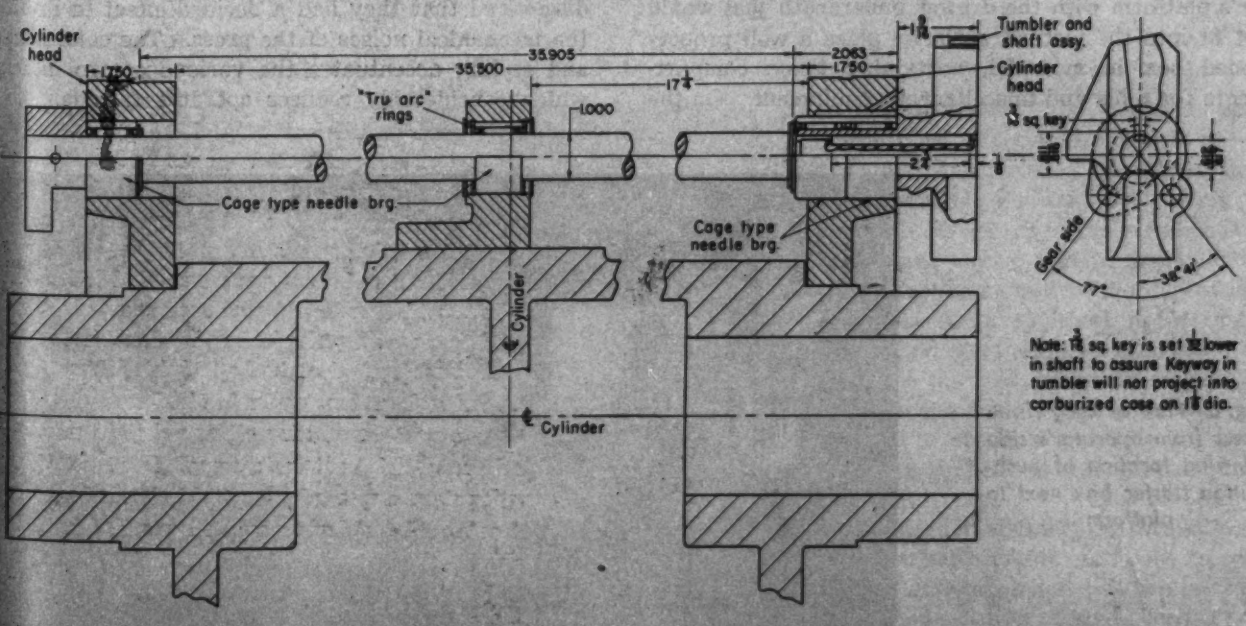


Fig. 5—Old and new arrangements of gripper shaft. Old shaft, above, running in bushings, had a tendency to whip at higher press speeds. New larger diameter shaft, below, is mounted in needle bearings to permit higher speeds

feeding of the paper, is driven by a one-horsepower constant-speed motor.

Three pushbutton control stations are provided on the Kelly Three press. One four-button station is mounted on the cylinder housing, directly above the operator's platform; a stop pushbutton is located at the rear of the extension delivery; and the automatic strip station is mounted on the operator side of the feeder frame.

The stop station on the extension delivery of the press and the automatic trip station stops both motors. Either the press motor or the air pump motor can be stopped independently by individual stop buttons on the four-button main station. There is a hold-down latch on this control station for holding the press motor stop button. When this is in position, the press-start button gives inching only, regardless of whether the trip circuit is open or closed. With the above latch disengaged, the press start button gives inching if the trip circuit is open, and gives run if the trip circuit is closed.

Both of the motors are mounted on floor plates directly beneath the feed pile board and could not be moved without major changes in the design of the press. Nevertheless, it was felt that if they could be covered it would greatly improve the appearance of the press. A flat panel across the feeder end of the press up to a level with the lower feed board connects with the side guards on both sides of the press and presents a smooth, continuous line around the feeder end of the machine, enclosing the motors and air pump yet leaving them open to sufficient cooling ventilation.

Operator's Position Improved

The pushbutton starter box is styled to blend with the cylinder housing guard on the operator side of the press, *Fig.* 6. The rigid conduit runs behind the guards, down through the rear of the new combination platform and tool box, thence back to the motor compartment, with no part exposed. The old operator's platform with the drawer underneath just would not fit into the picture, so in its place a well proportioned box is mounted, containing three compartments for tools and miscellaneous equipment. On the top of this box, a steel floor-plate lid hinged at the rear serves as an excellent platform for the operator.

The tachometer is moved slightly from its old position by means of a new mounting bracket, thereby keeping it in full view of the operator but well hidden behind the new upper feeder frame guard. A Bijur oiling system pressure gage, which had always been mounted on the operator-side press frame near the delivery end, was merely brought forward far enough to be flush with the guard.

Finish Changed to Two-Tone Grey

Moving back to the gear side of the press, the industrial designers called for a round drum-head type guard for the cylinder gear. This guard is spun aluminum and polished to enhance the overall appearance of the press. It was discovered there were several oiling points on the gear side of the press which were covered by the new guards and were formerly oiled by hand. As a solution to this, the pressure oiling system was extended to include these stations, thereby resulting in a definite functional improvement in the press.

Finish on the Kelly No. 2 was black wrinkle baked enamel. The color scheme for the new press is two-tone grey, smooth, baked enamel, with the lower portion in the darker grey. Name plate and company insignia were newly styled and affixed to the upper portion of the feeder frame guards and control box hood on the gear side and on the cylinder housing guard on the operator side.

A final test was run on the first new press using a maximum size form, made up of sixteen 6 x 9-inch pages, each page solid type. The press was run up to its new top speed of 3500 impressions per hour and gave excellent results on clean, sharp printing and hairline register. Its new weight distribution, effected by heavier frames and the lighter type bed, showed a marked improvement in smoothnes of operation. While the streamline guards were primarily intended to give the press a new appearance, it was discovered that they had a decided effect in muffling the mechanical noises of the press. The color scheme and styling accentuates the various control stations which considerably reduces operator fatigue.

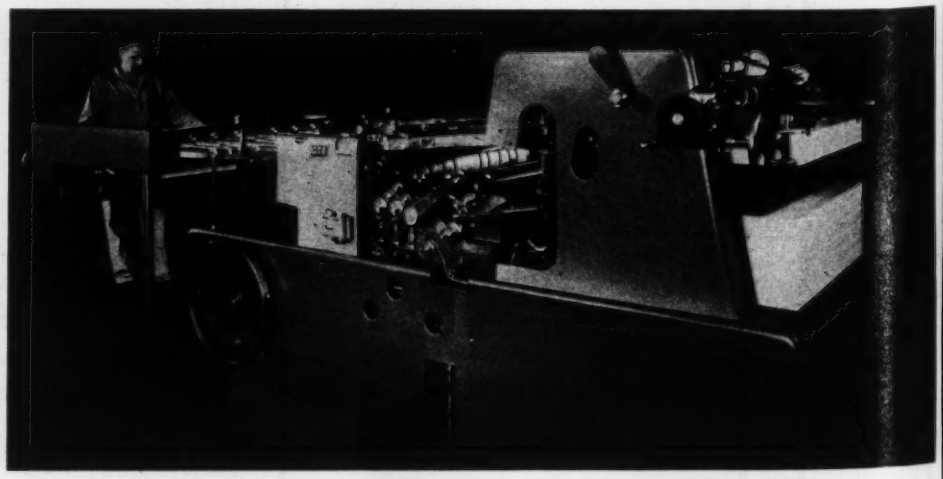
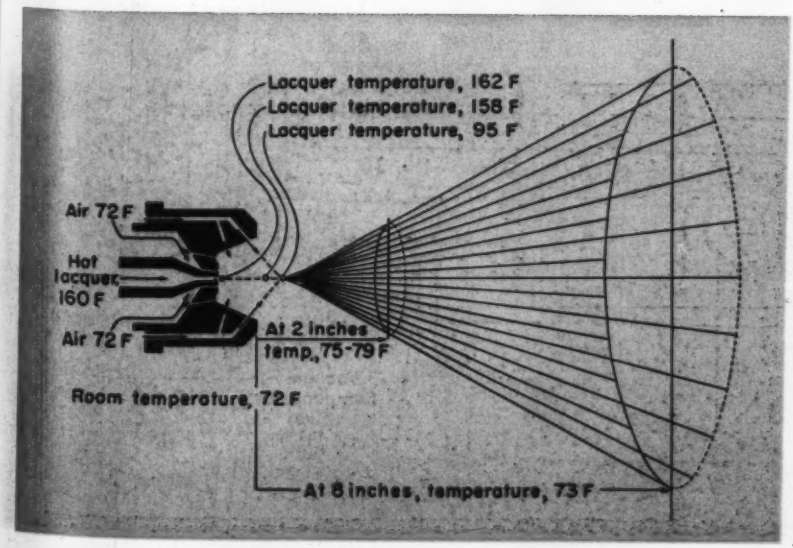


Fig. 6—View of Kelly Three press from operator's side showing location of push-button starter box next to platform

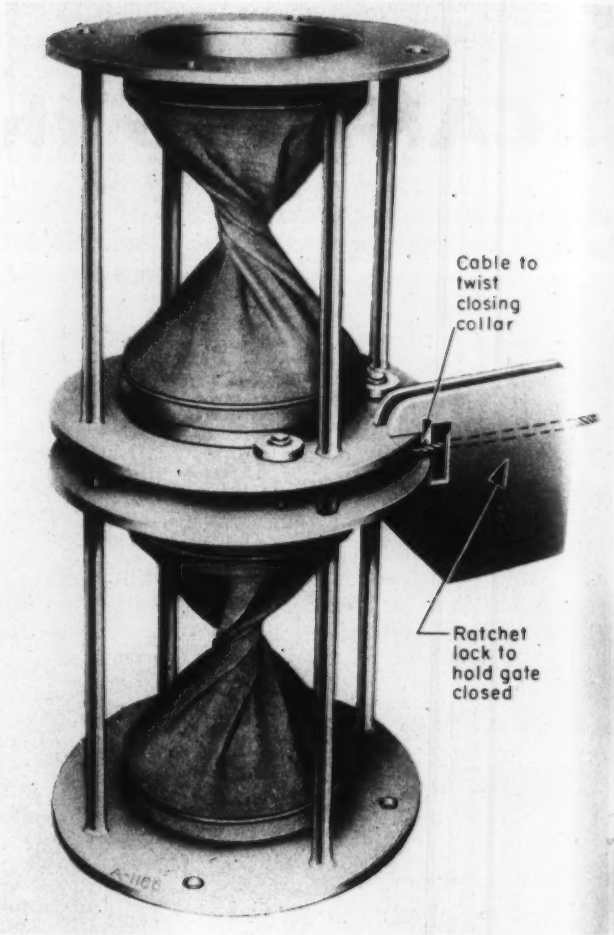
SCANNING the Field For Ideas

Pattern tool, left, for oddly contoured tanks to fit available spaces within submarines employs the "target" method of pattern making. Drawings and calculations would often require extended work. Instead a mock-up is built from which the pattern may be accurately determined by rolling the target over the pattern paper, marking all outline points. In the method, developed by Ralph C. Hickernell, two heads into which half-shapes of the top and bottom can be clamped are positioned for perpendicular height and angular adjustment, the latter taking care of desired taper. This setup makes a pattern for one-half the transition piece, which can be square to round, rectangular to round, round to round, or square to rectangular, for right or oblique ends.


Lacquer temperature, 162 F
Lacquer temperature, 158 F
Lacquer temperature, 95 F
Air 72 F
Hot lacquer 160 F
Air 72 F
At 2 inches temp., 75-79 F
Room temperature, 72 F
At 8 inches, temperature, 73 F

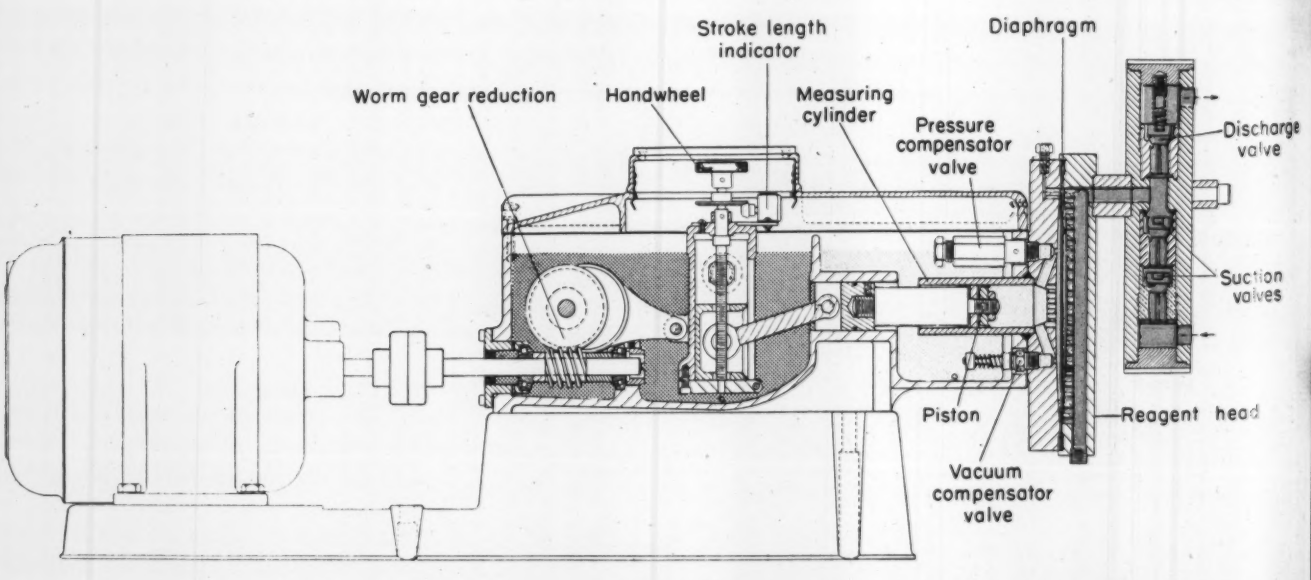
Hot-spraying of lacquer shows promise of effecting economies in material and labor costs. Extensive studies by Hercules Powder Co., using six different types of commercial heating equipment, have shown that nitrocellulose lacquers may be hot sprayed to give the same physical properties as when cold sprayed and that as much as twice the film thickness may be applied in one coat. Also, solvent savings amount to about 15 per cent per pound of solids applied. If desired, the quality of lacquer may be improved through the use of higher viscosity nitrocellulose or a higher ratio of nitrocellulose to resin. In the nozzle sketch at left are indicated the temperatures found during the spraying of a lacquer at 160 F, using

room temperature air for atomization. Lacquer deposited on the target eight inches from the gun is approximately at room temperature, greatly reducing the chances of the finish "blushing" during application.



Rubber sleeves in the "valve" at right are not affected in their operation by lumps caught in the valve during closing. The rubber sleeve merely wraps around any lumps, closing tightly without leakage. Designed by Stephens-Adamson Mfg. Co. for use in bins handling lump and fine materials, the valve is simple in construction, having no gaskets, packing or sliding joints. Two rubber sleeves are joined to each other by a rotating steel collar. Closure is obtained by rotating the collar to twist each of the sleeves. Elasticity of the rubber makes the valve self opening by resuming cylindrical shape when the collar is released. When open, the valve has no restriction to flow because of its straight-through construction.

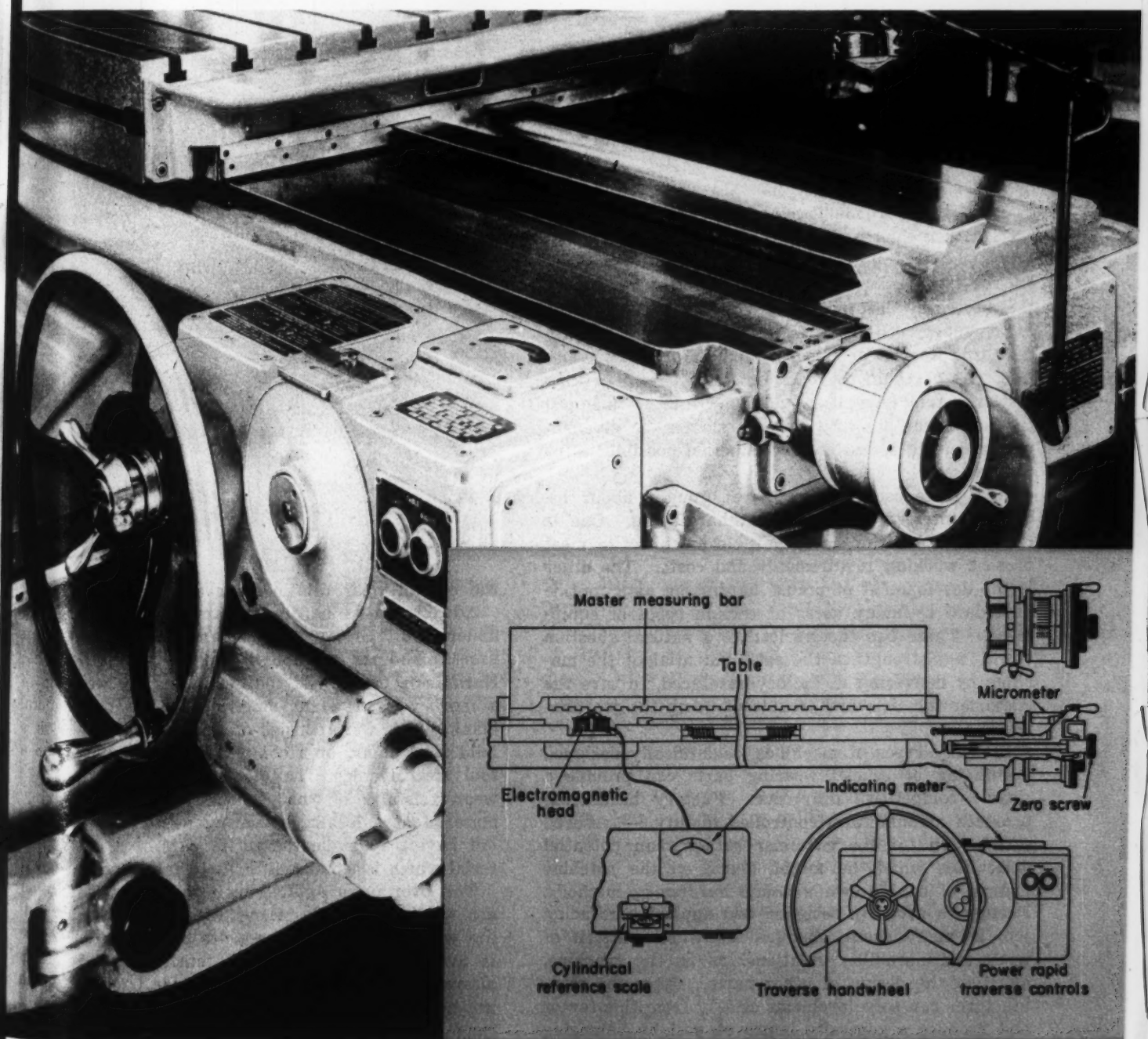
Combination piston-diaphragm pump, below, is a pressure metering device designed by the Lapp Insulator Co. to handle corrosive liquids without the possibility of leakage to atmosphere or of contamination by lubricating oils or greases. The left-hand or piston unit is an enclosed hydraulic system, having both suction and discharge valves. Normally these valves do not function because the diaphragm of the right-hand pump operates in synchronization with the piston. Liquid-handling check valves in the right-hand unit function with every stroke of the diaphragm. This diaphragm can be metal, plastic or synthetic, depending on the liquid being handled. Its stroke is determined by that of the piston and is controlled by a handwheel setting.



As shown in the diagram, the main drive crank oscillates a pivoted member having an adjustable slide to vary the piston stroke. Because this stroke is adjustable during pump operation an automatic control to adjust the stroke for maintaining a proportional delivery may be utilized.

Accurate measuring system, below, locates workpieces on a Pratt & Whitney jig borer by employing master measuring bars having accumulated errors less than twenty millionths of an inch over their entire gage length. Basic spacing on the bars is measured by electromagnetic heads which detect the centers of projections precisely one inch apart over the length of the bars. Two of these bars are built into the machine at right angles with each other, one 60 inches long on the underside of the table and the other 36 inches long on the underside of the carriage.

This basic spacing is subdivided by positioning the magnetic head between any two projections on the master bar with a high precision micrometer screw. The micrometer barrel on this screw permits direct settings to 0.0001-inch. A separate screw within the micrometer screw is used to zero the electromagnetic head under the nearest projection on the master bar to establish an initial zero position on the workpiece. Cylindrical reference scales revolve as the table or carriage moves. These scales read in either direction and are adjustable to zero for a starting position. The traversing screws of the two slides have no connection with the measuring system and therefore cannot affect the accuracy of a setting.



HARDFACING

—a design tool

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BECAUSE hardfacing has always been considered as a maintenance and repair process rather than a design tool, much of the know-how and technique concerning it is unsuited to production-type applications. This does not mean that the necessary information for sound designing of factory-hardfaced parts is not available. It is only that this knowledge has received limited dissemination. As a result, the possibilities of the process as a design tool have been neglected, but it is hoped that sufficient practical information can be given in this article to reveal some production possibilities of the process.

Two juxtaposed factors have brought about increased interest in factory-part hardfacing. One is the need for better, more durable machines to meet present working requirements and costs. The other is the development of preuse hardfacing as a routine procedure by many users of certain types of equipment. These two factors lead to a natural question —why not strengthen the sales potential of the machine by delivering it, factory-hardfaced, to save the customer the time and trouble of doing the job himself?

In many types of machines, scientifically designed hardfacing of crucial wearing parts can provide a sizable competitive difference. Factory hardfacing provides manufacturer-controlled quality — assured satisfaction for the customer rather than potential difficulties which he might blame on the machine instead of on his own unsound hardfacing methods. Further, a properly designed and applied hardfacing job, in many cases, changes the whole pattern of wear and durability relationships in the machine, affecting the design of other parts. Often the manufacturer can solve problems arising from this factor and produce a generally improved unit by balancing the overall wear relationships of the critical parts.

Advantages of hardfacing are not always clearly understood. Briefly, the fundamental nature of this process and its usefulness may be summarized as: Hardfacing consists of the overlaying, by welding, of a more wear-resistant material upon a basic metal blank. This may consist of a high-alloy steel on a mild steel blank, or a complex nonferrous alloy on a tool steel blank. The purpose is to provide high wear resistance of what is usually an expensive alloy material at a localized wearing point or area, without having to make the entire part of a costly material which is usually difficult to fabricate.

The overlay is applied by either oxyacetylene or arc welding methods, using an alloy chosen to suit the wear and life requirements of the part. There is available a wide range of such materials, from alloyed steels to the tungsten carbide particles which are next to the diamond in hardness. From such a range, which includes many gradations of qualities,

Fig. 1 — Left — Wear-resistant alloy being applied to the stem of a gas engine valve. Seat area of the valve is hard-faced with a heat-resistant alloy

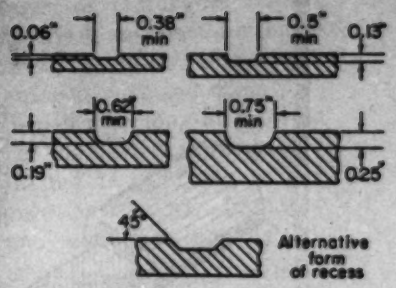
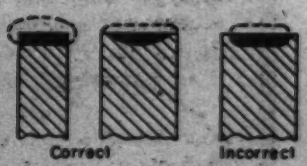


Fig. 2—Above—Recesses suitable for hardfacing deposits showing radius at bottom corners, or sloping sides, and depth to width ratios

Fig. 3—Below—Preparation of the end of a stem or shaft for hardfacing. Cap treatment for small parts is shown at left. In the center is a curved shallow recess. At right is an incorrect type of recess which will result in battering and spalling of deposit



an alloy is available to do the job required when properly applied and finished.

When hardfacing is to be considered as a production, rather than a maintenance, operation, it is often possible to obtain greater economy and better results. More precise techniques can be used; the part may be more readily adapted to an ideal appplication; closer control of application and results can be obtained. This, indeed, is a strong argument for factory-hardfaced parts, *Fig.* 1, on quality machines. To benefit from this potential improvement, the following simple steps of design and planning are necessary:

1. Determine wearing conditions of part
2. Select proper hardfacing alloy
3. Design efficient hardfacing deposit
4. Provide adequate design of blank part
5. Plan hardfacing procedure.

WEARING CONDITIONS: The part must be analyzed, not only for the job it is to do but also for the life-long conditions under which it must serve. Certain types of teeth, blades, etc., for instance, may wear considerably undersize before they become unusable, if they are so designed as to remain sharp. The possibilities of adjusting fits and clearances on other types of parts permit a tolerance of wear in some cases, provided the wear is so distributed as to permit continued efficient functioning. In many instances, peculiarities of service conditions require hardfacing deposits to be in apparent contradiction to the theoretical ideal—permitting deliberate sacrifical wear of one area or part to maintain the efficiency of another. Whether such special considerations or the more typical all-around wear-prevention are required, it is important that the designer have the fullest understanding of the wearing conditions of the part.

SELECTION OF HARDFACING ALLOY: Service conditions of a wearing part vary widely over the whole range of possibilities, including abrasion, impact, heat, corrosion and erosion. Seldom is one form

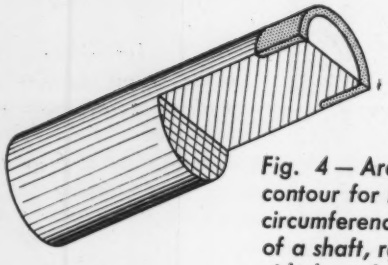


Fig. 4 — Area and recess contour for hardfacing the circumference at the end of a shaft, radii being provided at both inner and outer corners

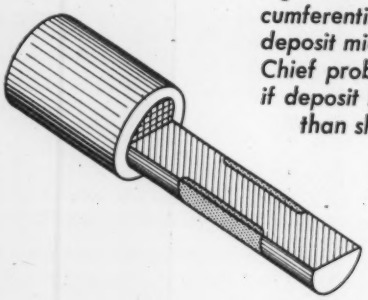


Fig. 5—Recessing for a circumferential hardfacing deposit midway on a shaft. Chief problem is distortion if deposit length is greater than shaft diameter

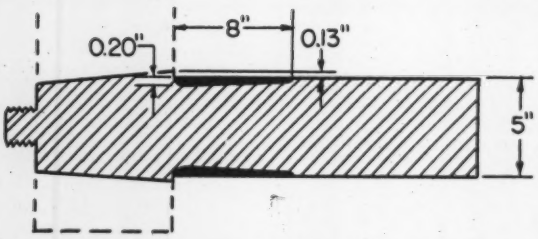


Fig. 6—Above—Shaft hardfaced to resist gland packing wear and corrosion. Heavy end of deposit operates in a corrosive medium

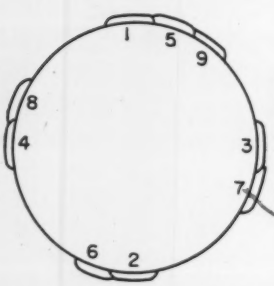


Fig. 7 — Sequence procedure for hardfacing a shaft with longitudinal stringer beads. Application of beads diametrically opposite equalizes distortion

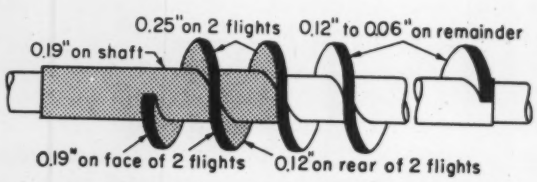


Fig. 8—Plan for hardfacing protection of a cement conveyor. Part of the shaft, two flights of the screw and entire periphery of screw are protected against wear

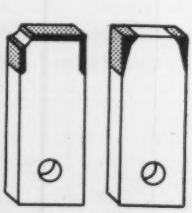


Fig. 9 — An incorrectly hardfaced mill hammer which failed in use is shown at left. The thin shell of hardfacing was insufficiently supported and cracked at the corner. At right is correct application, the end face being more useful as support

found by itself. In greater or lesser degree, they occur in combination. Further, the conditions on different areas of the same part may vary. For instance, large internal-combustion engine valves require resistance to heat and sliding abrasion on the stem, to heat and impact on the head.

In other cases, where impact and abrasion combine, the emphasis on the tip of a tooth may be heavy impact with moderate abrasion—but will shift to heavy abrasion with moderate impact in an area below the tip. From this, it may be surmised that selection of the proper alloy is not always an easy matter. It is not, however, as difficult as it might seem. For most types of service, experience has proved the best material to use; for other conditions, the help of hardfacing specialists is available through the manufacturers of the alloys. Sometimes, where service conditions differ on separate parts of the unit, different alloys will be required for different areas. At other times, a satisfactory compromise material can be selected. In these, or any other cases, it is a good general rule to select the material that will do the best possible job of combatting the problem, regardless of cost. The following tabulation classifies typical hard-facing alloys suitable for facing with weld overlays. None of these alloys require heat treatment. They are hardened as deposited, by air cooling, or by work hardening.

1. **High-carbon low-alloy steels**
   CHARACTERISTICS: Both welding rods and electrodes are available which produce deposits that are air-hardening steels with a structure which is essentially martensitic

   USES: The toughness and high hardness of deposits recommend alloys for applications involving impact and abrasion. They are used in earth cutting and crushing equipment

2. **High-carbon medium-alloy steels**
   CHARACTERISTICS: These are essentially martensitic air-hardening steels, chromium is included as an essential element because of its effect on air-hardening and wear resistance. Deposits are not machinable but can be forged without any reduction in hardness on completion of the forging operation

   USES: These deposits give abrasion and impact resistance. Typical applications are wobbler ends, swing hammers, dozer tips, crushing equipment, tamper bars, buckets, etc.

3. **Alloy cast iron** (6-12% total alloy)
   CHARACTERISTICS: Deposits produce martensitic matrices containing hard special carbides. The deposits exhibit exceptional abrasion and metal to metal wear resistance and also have hot hardness properties. Tougher than tungsten-carbide deposits but less expensive, deposits are nonmachinable and must be ground if a finished surface is desired

   USES: For applications where abrasion is severe and impact is moderate, for example, mixer blades

4. **High-carbon-chromium steels**
   CHARACTERISTICS: Deposits are soft but develop additional hardness on being subject to hattering or impact. Hardness is on the surface due to cold work, while a relatively soft un-

derlayer cushions the severe impact, and the hard surface resists abrasion

USES: For those applications requiring severe impact and abrasion resistance

5. **High-carbon-chromium-nickel steels**

CHARACTERISTICS: Deposits are tough, corrosion resistant, and will work harden. Hardness of deposit 30 to 50 Rockwell C due to work hardening

USES: Deposits are selected for their impact resistance, for example, on manganese steel frogs

6. **High-manganese steel**

CHARACTERISTICS: Electrodes are available bare and coated to give deposits containing 0.80% carbon, 14.0% manganese, and 4.0% nickel. This gives tough work hardenable austenitic deposits

USES: For surfacing cast manganese steel such as dipper teeth, and lips, etc., and for facing cast iron

7. **High chromium cast iron**

CHARACTERISTICS: This is a 28% chromium alloy that characteristically produces an austenitic deposit containing scattered crystals of hard chromium carbides. Deposits polish with use, resist galling and pitting, and have red hardness characteristics. Deposits are nonmachinable

USES: For cutting edges on agricultural equipment having severe earth abrasion and moderate impact

8. **Cobalt base alloys** (containing tungsten, chromium and carbon)

CHARACTERISTICS: Cobalt base alloys are useful because they have a greater degree of hot hardness than the iron base alloys. In brief, this means that they retain their hardness at higher temperatures and, therefore, are more capable of resisting wear under conditions where surface temperatures are developed by friction or by other causes. They are also highly resistant to corrosion, and for all practical purposes are nonmagnetic. Because they are nonferrous, they should be applied in such a manner that the dilution from the base metal is eliminated or reduced to a small percentage. Deposits range in hardness from 40-45 Rockwell C. Hardness and abrasion resistance increase with carbon content of the alloy while toughness and impact resistance follow the opposite trend. Deposits are machinable

USES: For applications where corrosion with impact and abrasion or heat with impact and abrasion are factors. Typical applications are valve seating surfaces, shear blades, conveyor parts, pump shafting, etc.

9. **Tungsten carbide** composite or tube rods

CHARACTERISTICS: Composite rods are made by casting sized material in a steel matrix. Tube rods consist of a steel tube filled with sized tungsten carbide. The most abrasion-resistant material commercially available, the weld deposit consists of undissolved tungsten carbide particles retained in a tough alloy matrix

USES: This type of deposit is useful for resistance to wear from earth moving or earth drilling. Deposits of rods containing fine particles are smooth, thin and flat, which wear to a sharper cutting edge and are useful for plow shares, knives, etc.

DESIGN OF BLANK AND HARDFACING DEPOSIT: The fundamental design principles for a hardfacing deposit are simple and straightforward: Put the alloy where it will work efficiently. Don't put it where it is not needed. Use just as much hardfacing as will do the job and no more. Plan the deposit for efficient application and a minimum of finishing.

One of the key advantages of factory-hardfacing is the freedom in designing the blank part for hardfacing. A suitable material, usually being much cheaper than that for an unfaced part and often providing better basic properties as well, may be selected readily. The whole design of the part can be modified or adapted to utilize hardfacing to advantage. The blank can be recessed, grooved, or otherwise prepared for the most satisfactory and economical application.

HARDFACING PROCEDURE: It almost goes without saying that the success, economically as well as functionally, of a factory-applied hardfacing job depends upon the application of the deposit. As with other welding operations, a wide range of possibilities is available, from simple manual operations on small jobs to elaborate automatic deposition on massive and critical parts such as steel mill rolls. Between these extremes, the possibilities of jigs, fixtures, mechanized arrangements, and other facilities for high-production, consistent-quality work with manual or semiautomatic operation offer a wide range of choice and a fruitful field of exploration. Big jobs such as construction machine parts, conveyor screws, etc., both by their nature and by the normal methods of manufacture, become straightforward large scale manual welding assignments. Many small parts, however, can be handled in fixtures which permit the best possible welding in minimum time.

Minimizing Dilution of Deposit

APPLICATIONS: In designing a specific deposit on a specific part, there are certain basic considerations of practice to be kept in mind. The hardfacing material is hard because of its alloy content, and as far as possible, deposition methods and techniques should be held to those which will minimize dilution by the parent metal. When more than one layer is required, this problem is minimized, but single layer deposits, being more of a dilution problem, should have an increased thickness.

In general, 3/64-inch is as thin a deposit as is practical to specify. If the deposit is to be ground, it should not be thinner than 1/16-inch. With increasing size of the part, the thickness of the deposit generally increases, allowing for 3/32 or ⅛-inch after grinding. Subject to such minimum thickness considerations, the deposit on a new part should be planned for a thickness which will either give the same life as other areas of the component, or be the same depth as that of the permissible wear on the part before it must be taken out of service.

As far as preparation of the part is concerned, all parts may be divided into two classes: One is the group of parts such as scraper blades, plows, excavator teeth, etc., which are rough parts and on which the deposit can usually be applied over the gross sur-

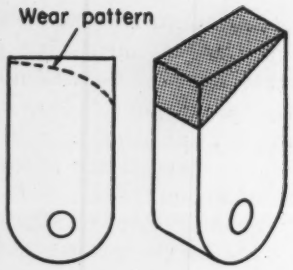


Fig. 10 — Wear pattern and plan of hardfacing hammer for crushing calcium carbide

Fig. 11 — Typical teeth for construction machines, showing correct deposit at (a). Incorrect deposit at (b) creates a blunt tooth which is apt to chip

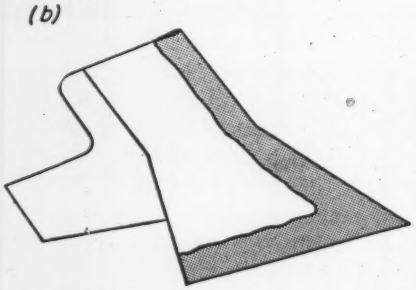
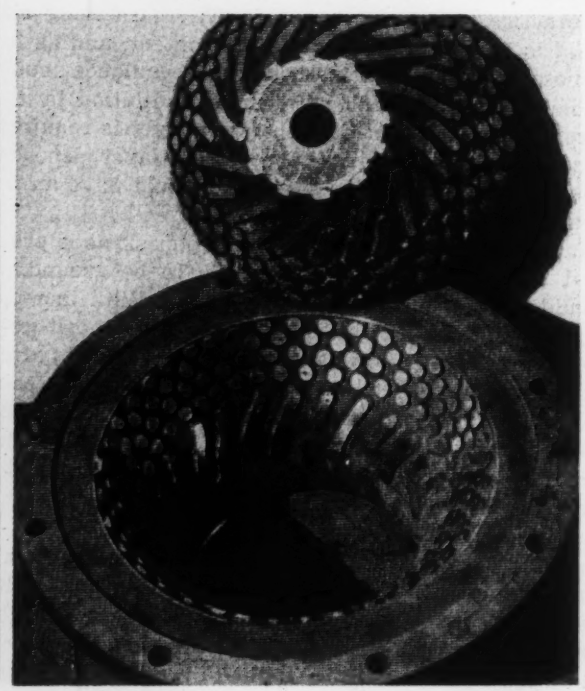


Fig. 12—Hardfacing deposit on blade-point of road building machine. Part combines treatment for a blade, a tooth and a flat area

Fig. 13—Below—These mating crusher cones for a food processing machine were designed around the button and rib pattern of a weld-applied hardfacing alloy



face after removal of scale and dirt. The second group includes most of the parts which are ground after hardfacing and all precision-fit parts. These require special preparation to receive the deposit, usually a groove or recess which is filled with the hardfacing alloy and ground to final dimension, *Fig.* 2. Such recesses are often designed into a rough-machined part so that a slight excess of metal in the part will be removed when the deposit is finish ground.

Sharp corners should be avoided and the recess should be shaped so that a minimum of surplus alloy will be required. Generally, recesses should not be narrower than ¼-inch even on a thin blank with shallow deposit, and a radius of at least ⅛-inch should be incorporated in the bottom corners. If desired, this corner radius may be so extended as to create a smooth flat curve across the bottom, which is particularly desirable on the ends of parts such as micrometer stems or valve spindles, *Fig.* 3.

Design of Recesses

Shafts are typical parts which demonstrate various aspects of hardfacing design. Depending upon the manner in which it is to operate, a shaft may require hardfacing at its end, where it operates in a packing, or over a sizeable length. In *Fig.* 4, is sketched the area and general contour of a hardfacing deposit at the end of a shaft as it might be prepared to withstand circumferential wear at that point. This being a corner deposit, in a recess, there is little problem of distortion during welding to consider, for the effects, such as they are, will be removed in finish-grinding.

Such a deposit, however, involves a somewhat critical welding area at the end corner on the open side of the recess, where care must be taken not to overheat the base material and cause excessive dilution of the alloy. This could be avoided by machining the part a little over-length, providing the recess with an outer wall, and filling the entire recess with hardfacing material, finally machining or grinding away the excess length and the outer wall of the recess in finishing. Such a provision, however, is only necessary where metallurgical qualities are critical.

Where the end of a shaft is to be hardfaced on the butt rather than the circumference, the same recessing and contour suggestion sketched in *Fig.* 3 would apply, and if both butt and circumference require protection, the recessing would be similar to that shown in *Fig.* 4, but the shaft would be a little under-length and brought to dimension with hardfacing.

When a section of the length of a shaft, such as the area to be contained in a gland packing, requires hardfacing, the recess for the deposit will be basically like that in *Fig.* 5. In such a case, the basic considerations of recess contour apply, and the technique must provide for protection of the sharp top corners of the recess. When a section becomes longer than the diameter of the shaft, provision must be made to prevent excessive distortion of the part.

When a shaft, as sketched in *Fig.* 6, must wear under more severe conditions at one end of the deposit than at the other, the deposit may be increased

in thickness where the more severe conditions apply —provided, of course, that in-use wearing tolerances will allow benefiting from the increased thickness of alloy. In the case sketched, the thin end of the deposit was prepared to resist wear, the heavier section was designed to resist corrosion, and the two balanced to provide increased life.

It might be observed that the greater the proportionate area of a part to be hardfaced, the greater become the problems. In the case of the gas-engine valve-stem in *Fig.* 1, hardfaced to resist wear and corrosion, the principal problem is that of distortion. If consecutive adjoining lengthwise stringers were deposited on such a part, it would warp and become useless before the deposit were finished. A sequence of deposition, designed to balance the effects of heating is outlined in *Fig.* 7.

The relatively simple problem involved in designing hardfacing protection for a shaft becomes more complex when it is brought into working relationship with other parts of a machine. For example, the conveyor screw sketched in *Fig.* 8 was originally designed for hardfacing the outer edge of the flights and the delivery end of the shaft including the last two flights. This deposit increased the service life greatly. Failure did not occur in the shaft or the edge of the flights, as it would with an unprotected part, but the front face of the last flight wore through. Maximum efficiency from the hardfacing was only obtained in this case by hardfacing the face of two flights at the delivery end, as well as the edges and the shaft.

This was a case in which offhand observation would indicate that protection at the edges of the flights would suffice. Trial proved that edges and shaft should both be protected to give greatly increased life, but that to get the full value of the hardfacing, its extension to the faces would be required. It is well, perhaps, to mention that the converse may also be true—that better value may be had from reducing the amount of hardfacing on a part. This would be true where the part fails in spite of protection, while other areas still show hardfacing deposits with long useful life remaining—indicating that service conditions on the failed section are so severe that protection for other sections is wasteful. The variables are such in these cases that only experimental parts can really provide a valid answer.

Wear Pattern Is Design Aid

Similar thinking applies in the case of less complicated machine parts. The hardfacing of hammers, for instance, for various types of crushing and pulverizing equipment, has become fairly well standardized. For alfalfa mills, for instance, the pattern of deposit, sketched in Fig. 9, has proved highly satisfactory, and the same pattern can be used for many other types of mills. When such a pattern was applied to the hammers for breaking and screening calcium carbide to commercial sizes, however, it would not deliver the expected life. The experimental approach was used to ascertain the wear requirements. By putting into service a set of hammers without protection, the wear pattern resulting from a combination of crushing impact and grinding action was established as sketched in *Fig.* 10. Then design of a suitable hardfacing cap became a relatively simple matter. Similar methods of analyzing wear conditions can be devised for other types of parts.

Maintains a Self-sharpening Edge

Other common types of parts which are hardfaced, particularly for agricultural construction and earth-moving machinery, are teeth. Whether they form part of a hay rake, a scarifier, or less commonplace machines, the basic theory of hardfacing is the same, as sketched in *Fig.* 11. While the area and extent of the deposit will vary, the deposit is almost always applied on the face side of the tooth only. Because of the wearing away of the softer body of the tooth, this practice maintains a self-sharpening edge or point, hard and durable. Attempting to obtain better results by completely pointing the tooth with hard alloy usually results in disappointments as the hard alloy will flake, chip, or develop blunt point.

Many earth-moving and earth-working equipment parts are protected or repaired with hardfacing as a routine operation by their users. The majority of these users hardface new parts before putting them into service in modern practice. This trend has been carried even further, and several leading manufacturers of this type of equipment are now applying the alloy overlays in the factory, particularly on the more specialized equipment where efficiency of operation is exceptionally important. The sketch in *Fig.* 12 shows the way in which a point-plow used with a multiple-stage roadbuilding machine is factory-protected against wear. The deposit is carried along the cutting edge and is built out at the point just as it would be for a pointed tooth, *Fig.* 11. Finally, to protect the nose of the plow, a wide flat rib of hardfacing material is carried up to the top on each side of the peak.

The examples cited are largely matters of designing improvements for existing machines, or conventional parts of machines. It is, however, possible to redesign a machine completely, or design an altogether new machine, with the aid of hardfacing materials. The two crusher cones in *Fig.* 13, for example, are for a special type of olive crusher which was developed around the application of hardfacing alloy deposited in strips and buttons, and ground to form round spots and flat top ribs with approximately 5/16-inch faces, resulting in teeth on both mating parts.

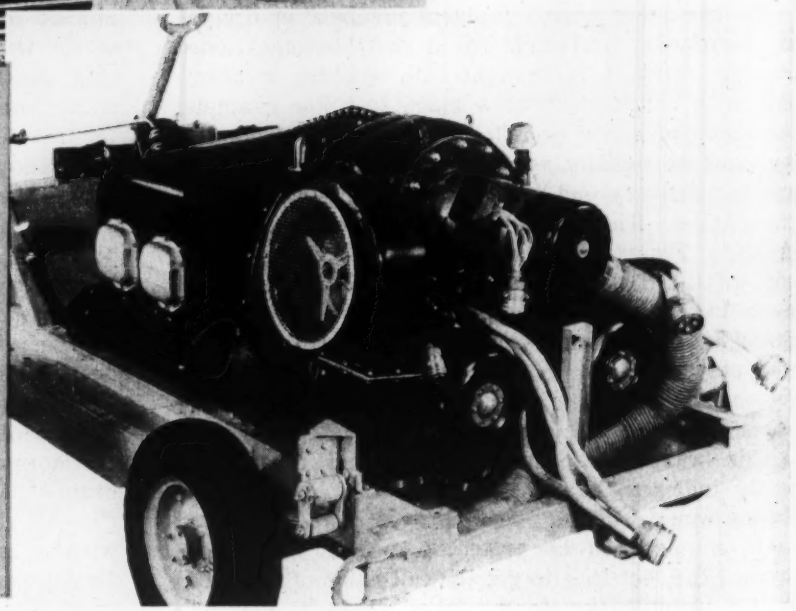
Such cases scarcely touch the possibilities for imaginative application of hardfacing materials in the design of modern machines. If parts are giving unsatisfactory service life because of excessive wear or if a machine which operates under severe wearing conditions is up for redesign, then it is well worth while to consider hardfacing in the design of the unit.

The author wishes to acknowledge his indebtedness to M. Riddihough, author of *Hardfacing by Welding,* (Cassier, London, 1949) for valuable supplementary material in the preparation of this article.

Lightweight air-cooled engine drives generators and alternator through speed increaser to supply starting current to aircraft engines. Simplified controls are centralized in one panel of the mobile plant. Preheater and automatic louvering permit operation at temperature extremes

Mobile Power Plant

. . . designed for unusual service



ALL-WEATHER performance, simple operation, and maximum portability and mobility dictated the design of the auxiliary power plant shown above. Now being produced for the Air Force, this mobile unit was developed jointly by that service branch and Lycoming-Spencer Div. of Avco Mfg. Corp. primarily to supply starting current for jet and large reciprocating engines. Thus relieving aircraft batteries of high initial energy demands, the unit is used also to charge batteries and for the checking of instruments, controls, radio, radar and similar installations prior to flight.

For minimum weight and bulk, an air-cooled engine is used as the prime mover. Rated 90 hp at 2200 rpm, this 4-cylinder aircraft type engine weighs approximately one-third less than a comparable liquid-cooled unit.

Electric power requirements of various applications are satisfied by three versions of the power plant: two for starting jet engines and one for reciprocating. All three supply both a-c and d-c, differing only in the generating capacity of each type of current. The most complex model, which is used for jets, carries two d-c generators rated 11 kw each, and one alternator rated 8 kw. Generating units and a blower for cooling them are driven by the engine through a speed increaser. A flexible splined coupling connects the engine flywheel to the central gear of the increaser. Separate take-off gears are splined directly to the generator shafts.

Provisions have been made for operation over an ambient temperature range of −65 F to 130 F. Before the engine is started at low temperatures, a gasoline-burning heater and fan system warms the lubricating oil and battery. After warmup, thermostatically controlled shutters on the housing, which completely encloses the plant, regulate the admission of cooling air to the fan-equipped engine.

All controls, except the engine throttle and choke for starting, are either automatic or pushbutton. Gages, meters, relays, switches, and other components are built into or operated from a control panel.

For easy mobility, the plant is mounted on a dolly equipped with three pneumatic-tired wheels. The axle for the two rear wheels is suspended on leaf spring shackled to the frame. The front end is supported on a swiveled wheel joined to a combination tow bar and brake.

Determining Practical Tolerances

By statistical means the probability of interferences can be positively determined to permit greatly broadened limits

By Wayne A. Ring
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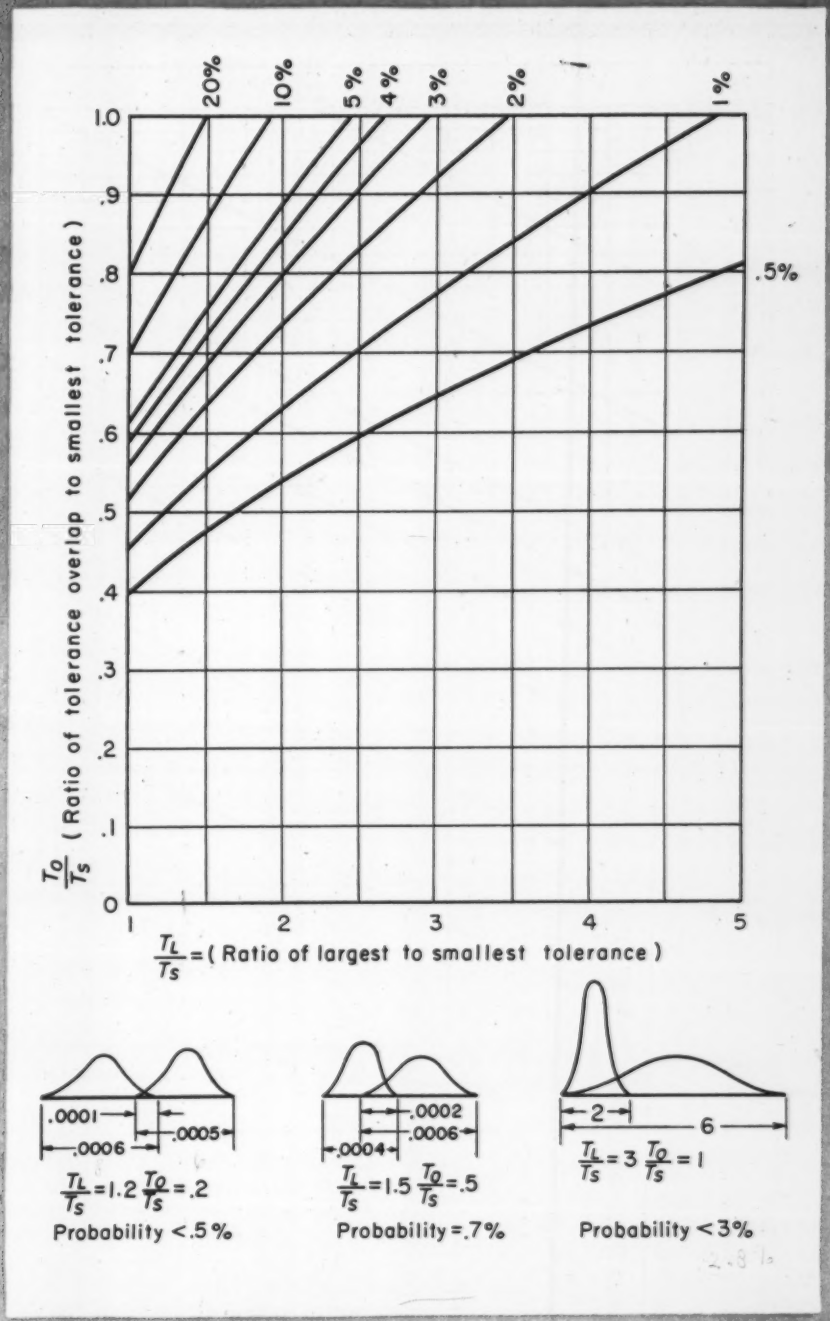
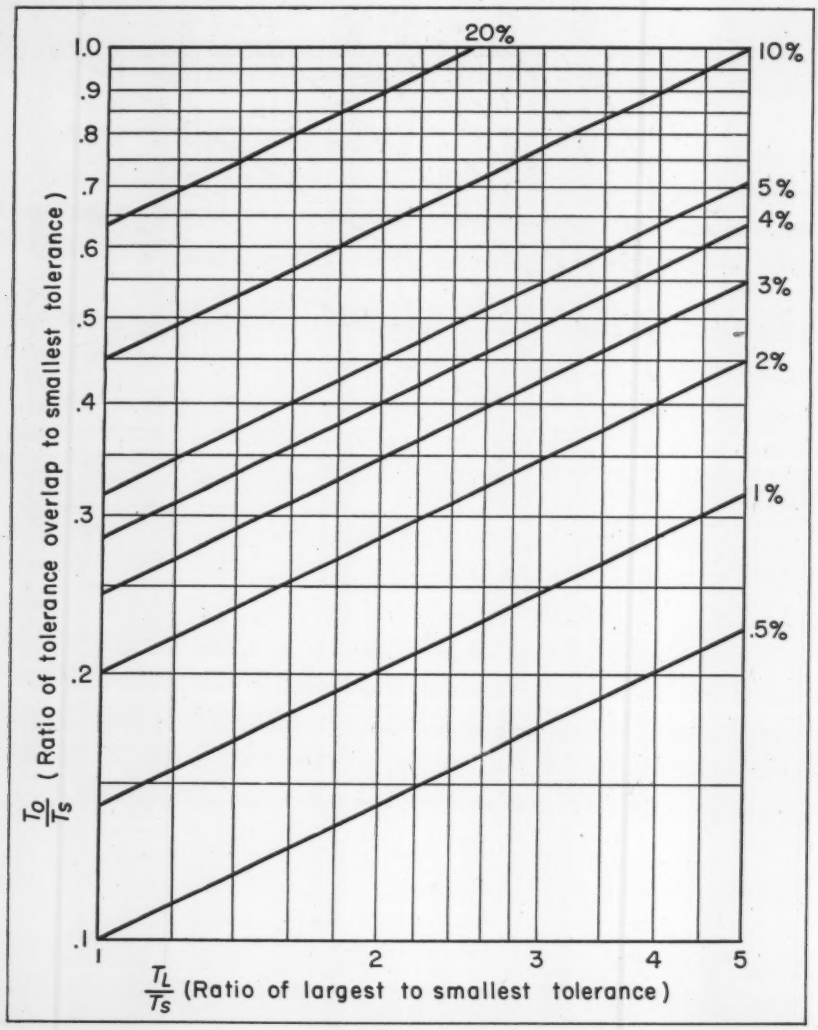


Fig. 1—Chart for determining probability of interference of two over-lapping normal distributions. Conditions are: (1) Tolerance is defined as 6σ where σ equals the standard deviation of the normal distribution and (2) pairs must be selected at random

FINAL cost of a product depends largely on the design or development engineer. Has he designed the parts to perform a task in a simple way; and if so, are parts dimensioned so they can be made at a reasonable cost?

With increasing use of statistical quality control, it is becoming apparent that probabilities should be considered when pieces are dimensioned. Of particular interest are fits of mating parts such as a tongue and groove or hole and shaft. The development engineer in dimensioning a study model usually takes no chances of interference or misfits; therefore, to obtain a desired fit many dimensions are held to extremely close tolerances.

As quite often happens, the original part details are used in making production drawings with a resultant comparatively high manufacturing cost. With the passing of time, tolerances are sometimes "opened up"



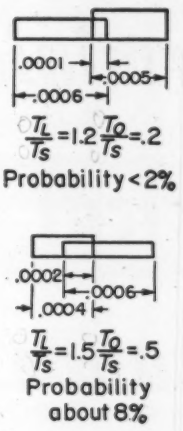


Fig. 2—Chart for determining probability of interference of two overlapping rectangular distributions

when experience shows that no difficulty arises. This delay is costly and can be avoided quite often if original dimensions are chosen wisely or if dimensions are given a review before drawings are released to production. The charts, *Fig.* 1 and 2, which accompany this article can be used as aids in the proper choice of final dimensional tolerances which assure lowest manufacturing cost, *if* production of the components is statistically controlled.

As pointed out by Hanna and Varnum,* dimensions of pieces made with statistically controlled *normal* distributions can often be widened so that they actually overlap with a very small probability of misfit *if* pieces are selected at *random*. For example, consider a tongue and groove made with normal distributions having dimensions of 0.8750/0.8745 and 0.8755/0.8749 respectively. To use the charts, determine the ratio of the tolerance overlap to the smallest tolerance (T_O/T_S = 0.0001/0.0005 or 0.2) and the ratio of the largest to smallest tolerance (T_L/T_S=0.0006/0.0005 or 1.2). Enter the chart, *Fig.* 1, with these values and determine a point by which the probability of misfit can be ascertained from the sloping lines.

In this case *Fig.* 1 indicates a chance of misfit well under 0.5 per cent. It should be pointed out that this is not all rework or scrap as the shaft of one misfit will probably fit the next hole. One can see the possibility of widening dimensions for ease of manufacture on pieces requiring close fits by accepting a small calculated risk of interference.

How can the engineer make use of the chart in *Fig.* 1 if only one or two pieces are to be made from his drawing, as happens in the making of study models? He feels the distribution of parts can hardly be considered a normal distribution.

The chart in *Fig.* 2 is made on the assumption that pieces will be made so that the chances of getting any dimension within the drawing limits are equal. This might be considered a conservative condition that exists when one or a few pieces are made. Using *Fig.* 2 for the previous example of a tongue and groove, it is seen that there is a probability of misfit of about 2 per cent. If the development engineer can take the conservative value of 2 per cent risk of mis-

* R. W. Hanna and E. C. Varnum—"Interference Risk When Normal Distributions Overlap," *Industrial Quality Control*, Sept. 1950.

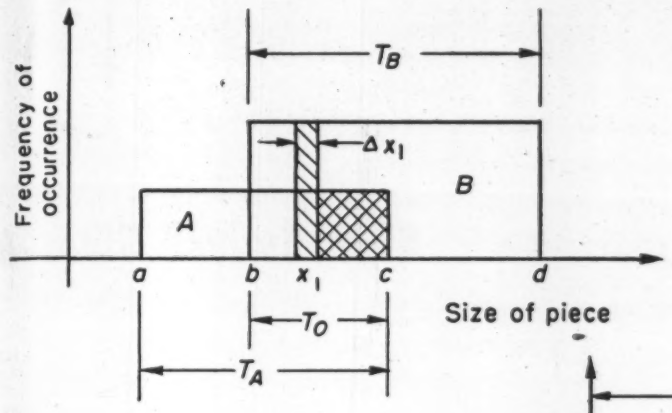
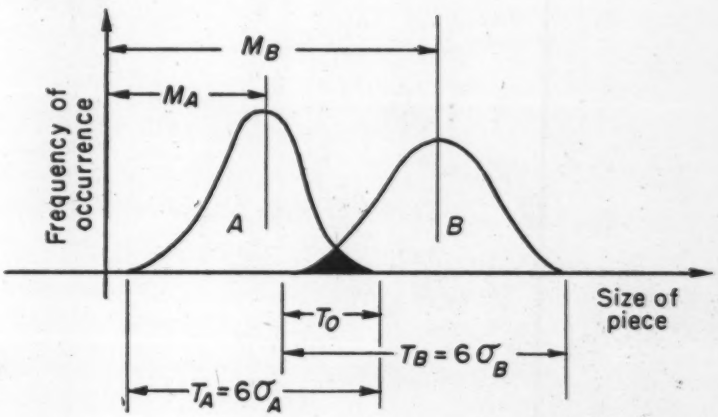


Fig. 3—Left—Plot showing case of overlapping rectangular distributions A and B. T_A, T_B, and T_O are the tolerances of distributions A, B and of the overlap

Fig. 4—Below—Plot showing normal distribution of parts A and B. Means of distributions A and B are M_A and M_B. T_A, T_B and T_O are the tolerances on A, B and overlap. σ_A and σ_B are the standard deviations of distributions A and B



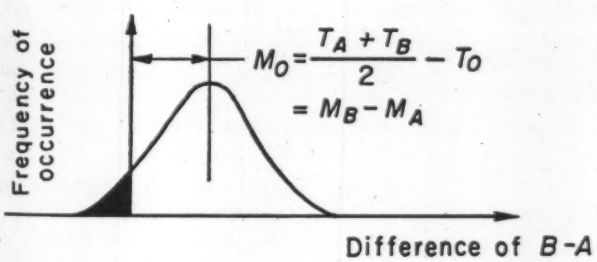


Fig. 5—Left—Distribution of B minus A where M_O is the mean of distribution of B-A, parts being selected at random

fit on a study model, he should use the widened dimensions intially on a piece that will later be in production with a normal distribution.

Since the probability of misfit is so much less than popularly believed, it is important that the underlying principles in developing these charts be understood. The case of overlapping rectangular distributions, *Fig.* 3, readily illustrates the fundamentals. The chances of picking a particular point x_1 in distribution B are $\Delta x_1/(d-b)$ where $b<x<c$. The chances of picking a point in A greater than x_1 would be $(c-x_1)/(c-a)$. The chances of both happening at once are $(c-x_1)\Delta x_1/(c-a)-(d-b)$. With x taking on values from b to c, the total probability of misfit is

$$\int_b^c \frac{(c-x)}{(c-a)\,(d-b)}\,dx = \frac{T_O^2}{2\,T_A\,T_B}$$

from which a chart such as *Fig.* 2 can be made.

The chart in *Fig.* 1 was developed less directly by the use of fundamentals of statistics found in standard texts.† In *Fig.* 4 T_A was chosen equal to $6\sigma_A$ and similarly for T_B since 6σ $(\pm 3\sigma)$ contains 99.7 per cent of the area under a normal curve.

By subtracting to completion a random part in A from a random part in B, the distribution in *Fig.* 5 is obtained. Here the shaded area of the curve is of interest for it is there that $B-A$ is negative and interference results. From statistics it is known that $\sigma^2_{B-A} = \sigma_A{}^2 + \sigma_B{}^2$. By the use of $T_A = 6\sigma_A$, $T_B = 6\sigma_B$ and $M_O = \frac{1}{2}(T_A + T_B - T_O$, this can be transformed to

$$\frac{T_O}{T_B} = \frac{1}{2} + \frac{T_A}{2\,T_B} - \frac{M_O}{6\sigma_{B-A}}\sqrt{1 + \frac{T_A{}^2}{T_B{}^2}}$$

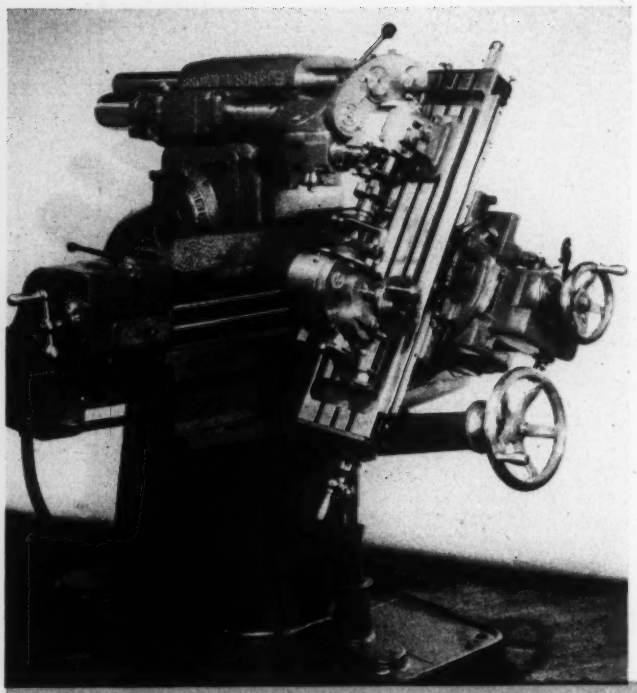
Values of M_O/σ_{B-A} can be calculated for various probabilities of interference by using tables of area under the normal curve, making a graph such as *Fig.* 1 possible.

With proper understanding, the charts of *Figs.* 1 and 2 can aid in the choice of dimensions to give desired or even improved fits at low cost.

† E. L. Grant—*Statistical Quality Control*, McGraw-Hill Book Company, New York, 1946, Pages 326-332.

Contemporary D

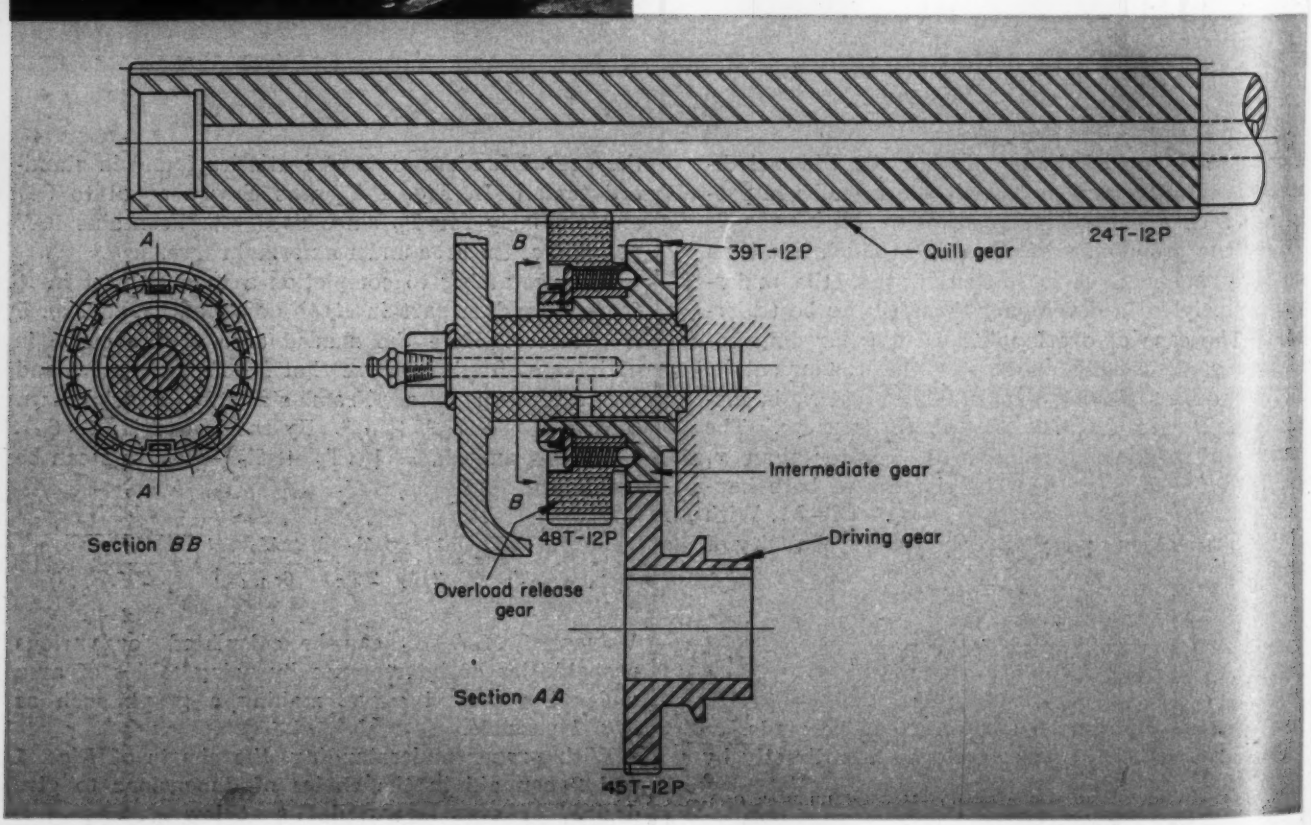
Knee Swivel Gives Mi



HORIZONTAL feed of the knee assembly and swiveling of the knee in a vertical plane are incorporated in the unusual milling machine shown at the left. Designed for tool room and experimental work, the Brown & Sharpe Omniversal machine permits precision milling in a number of planes and angles.

Design of the feed mechanism permits an infinite number of feed changes from ½ to 15 inches per minute through a ½-hp variable-speed electronically controlled feed motor which starts and stops simultaneously with the cutter spindle. The knee-rail table driving shaft provides movement of the table and spiral indexing head independent of the knee slide movement. Since an important use of the machine is for milling tapered spirals, which require the feed to give a cut of constant depth from the conical surface of the work, provision is made to synchronize the knee slide feed and rotation of the work.

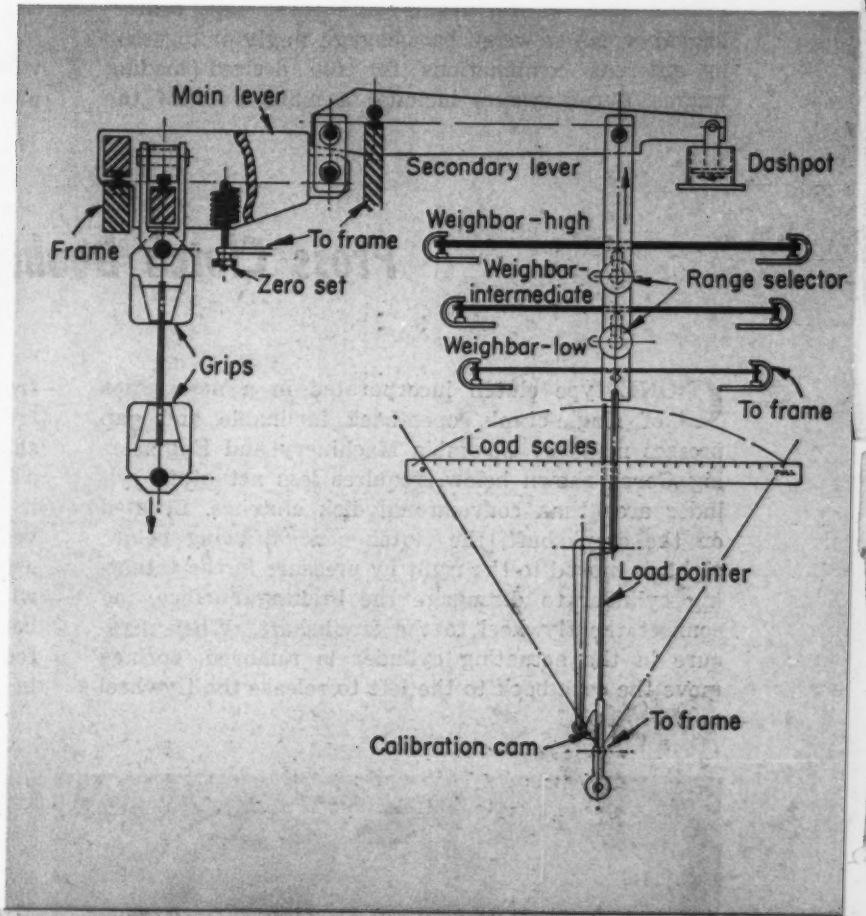
To increase the flexibility of the equipment, an



IGN

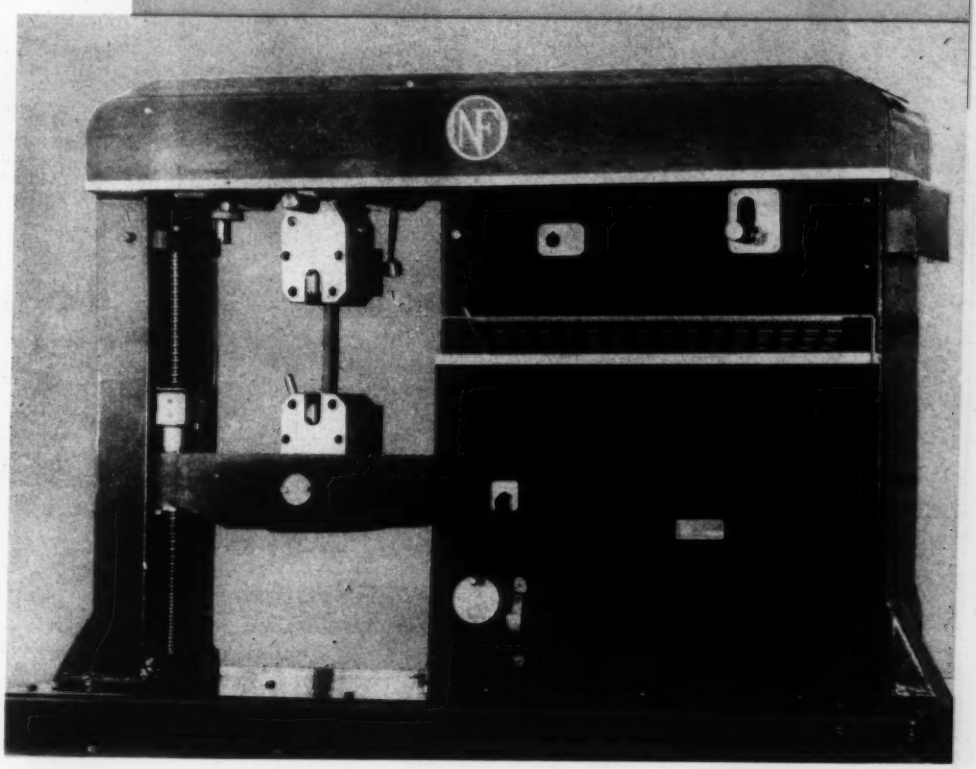
Versatility

auxiliary spindle—Omniversal milling head—is provided. This is gear driven from the machine spindle at double spindle speed and is suited for boring, reaming and other light machining operations. As shown in the drawing, left, below, the driving gear on the rear of the machine spindle drives the quill gear on the Omniversal head driving shaft through a gear containing an automatic overload release. The quill gear is mounted in a sleeve which permits longitudinal adjustment of the head. For maximum usability, the head unit may be placed in either overarm hole as well as in its normal position. The gear case housing and collapsible guard at the rear may be rotated about the machine spindle to bring the drive to the quill gear for any of the three positions. When only the machine spindle is to be used an intermediate gear is moved out of mesh with the driving gear, disengaging the drive to the milling head.



Mechanical Load Indicator Simplifies Tester

MECHANICAL loading and weighing systems are combined in the low-cost table model universal testing machine shown at the right. Loading screws rotate in ball-bearing nuts, the screw threads forming raceways for precision steel balls in an endless circuit. Loading per ball is kept low, with an ample safety factor. The screws will not jerk at rotational speeds approaching zero and backlash is eliminated by auxiliary spring-loaded ball-bearing nuts

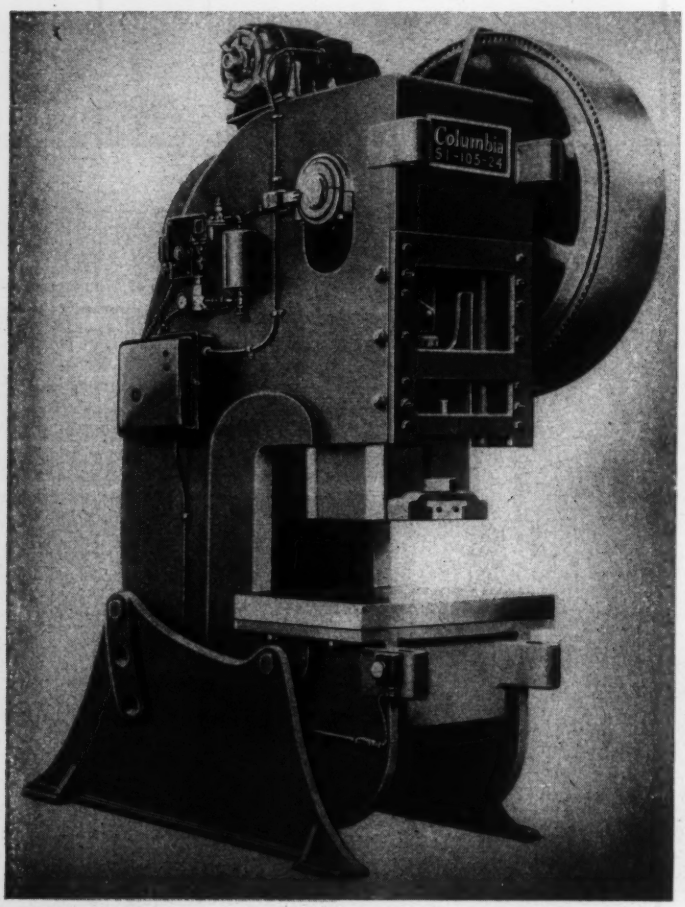


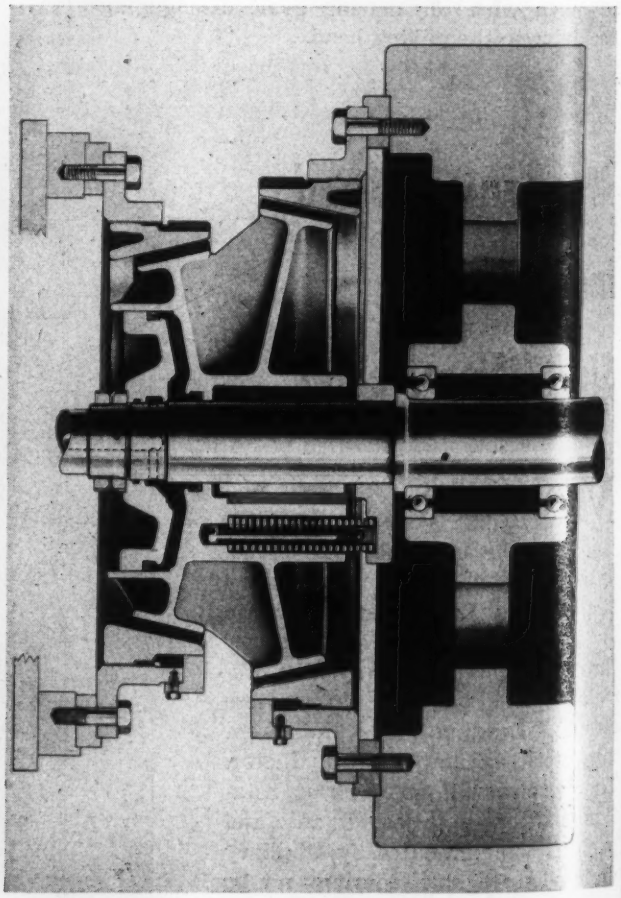
which lift the crosshead and preload the main pulling nuts. Crosshead travel rates from 0 to 8 inches per minute are provided by an infinitely-variable speed transmission with a fine-pitch roller chain drive to the lead screws.

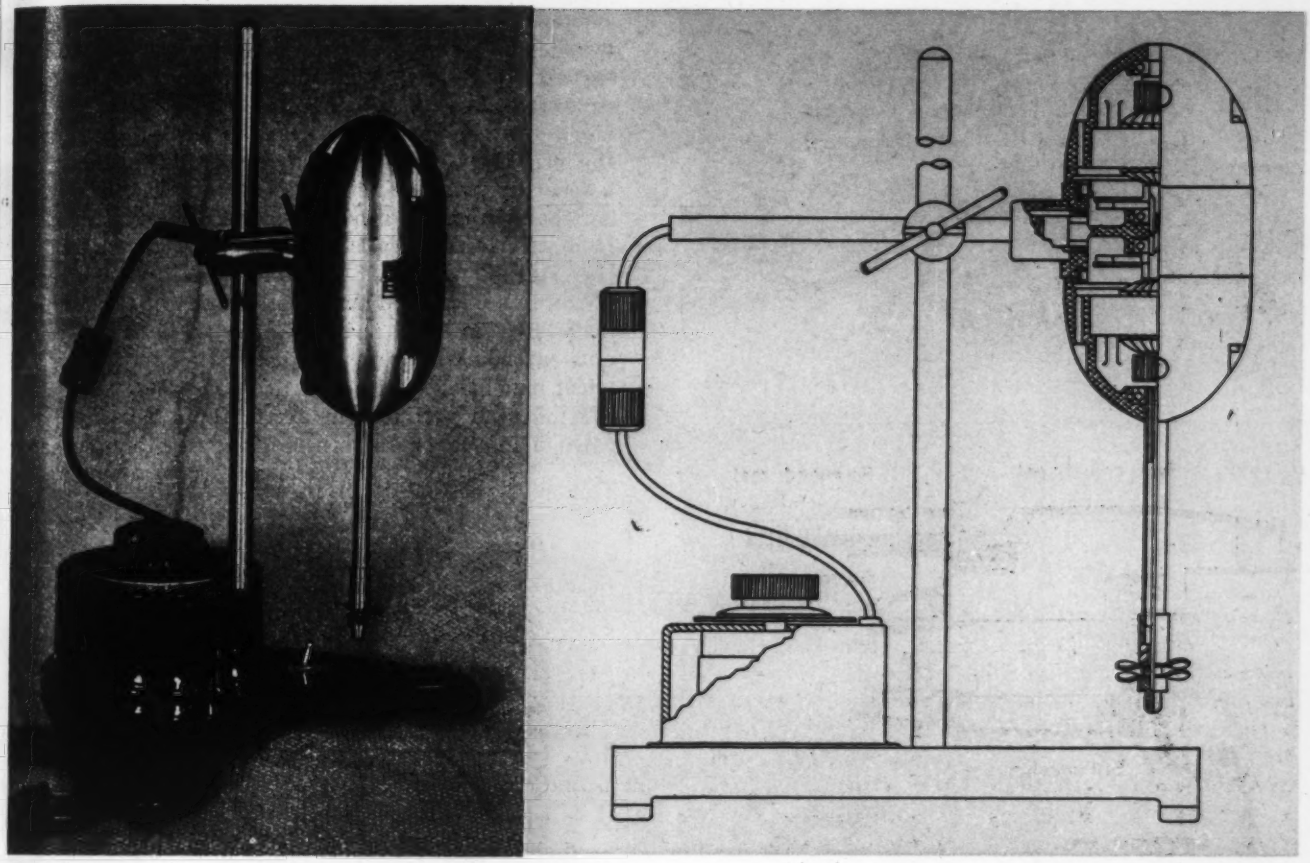
The load balancing system, top, previous page, consists of knife-edge pivot levers connected to calibrated, steel elastic beams; the three flat, center-loaded beams or weigh bars engage singly or together in different combinations for the desired loading range. Lever system includes a main lever of the second class and a secondary lever of the first class to provide a total reduction of 30 to 1, with recoil vibrations damped by a fluid dashpot. Made by National Forge and Ordnance Co., the machine provides for tension, compression, flexure, shear and transverse testing in capacity ranges of 15,000 and 30,000 pounds.

Press Clutch Doubles as Brake

CONE type clutch incorporated in a new series of single-crank, open-back inclinable and gap presses made by Columbia Machinery and Engineering Corp., shown below, requires less actuating cylinder area than conventional disk clutches. Located on the crankshaft, the clutch cone, drawing below, right, is moved to the right by pressure in the actuating cylinder to disengage the braking surface and connect the flywheel to the crankshaft. When pressure in the actuating cylinder is removed, springs move the cone back to the left to release the flywheel from the crankshaft and brake the latter against a friction surface on the press housing. The drawing shows the clutch in the disengaged position. Use of a 12-degree clutch cone angle has several advantages: it reduces the actuating force necessary and also prevents either the sticking which might result from a too sharp cone angle or the sudden seizure common with too large a cone angle. Making the clutch members of aluminum lessens the inertia or flywheel effect while increasing heat dissipation which results in less wear of friction surfaces.







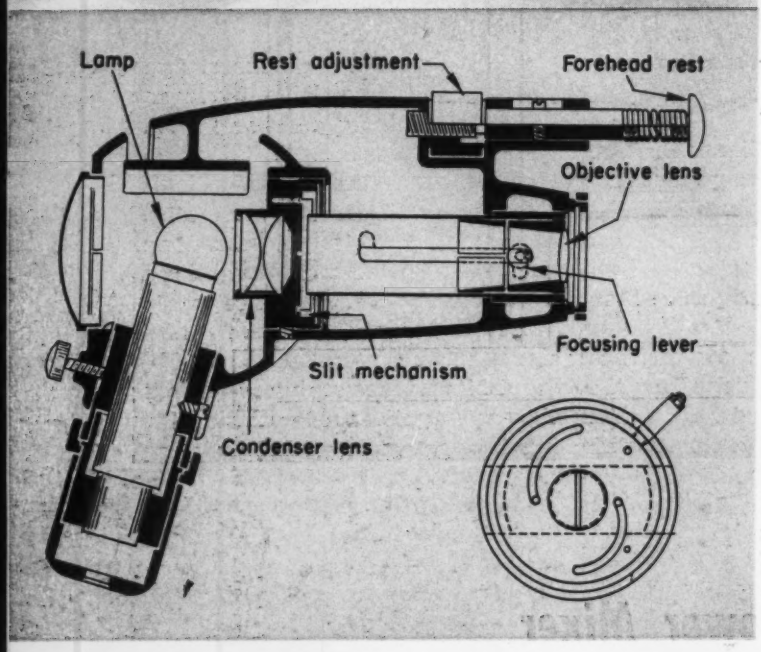
Dual Motors Power Mixer

INDEPENDENT motors driving two propellers in opposite directions permit better laboratory mixing with the unit shown above. Made by Brookfield Engineering Laboratories Inc., the mixer employs two 1/30-horsepower motors, each driving one of the propellers through concentric shafts, above, right, to draw the material through the shearing zone where it is submitted to as many as 48,000 scissor-like cuts per minute. Since centrifugal effect is minimized, no vortex is formed and the liquid level remains essentially constant. A continuously variable control permits speeds from 200 to 12,000 rpm. All immersible parts are stainless steel except a bottom guide bearing of leaded bronze.

Slit Lamp Designed for Portability

EYE examinations have heretofore required the use of cumbersome stationary slit lamp equipment. A portable lamp of this type, designed to supply a brilliant spot of light ¼-inch in diameter or a slit of any width down to 0.5-mm, is shown at the top, next page. Variation of the spot of light from a circle to a slit is controlled by the vertical movement of a handle, seen at the edge of the round housing in the photograph. This movement rotates a diaphragm disk which has two cam slots engaging pins on each of two horizontally sliding jaws enclosed in the slit mechanism housing, as shown in the sketch, center, next page. The edges of these jaws move in front of a circular aperture to provide any width slit.

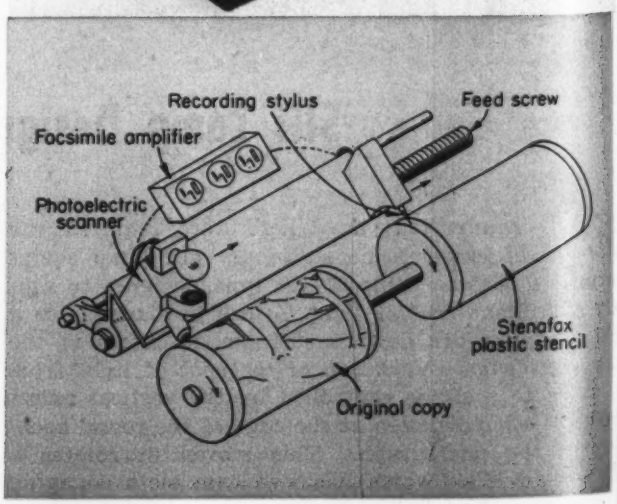
Size of the spot of light can also be readily adjusted up to several inches in diameter for use as a spot light or operating lamp. Movement of projecting pins or focusing levers along a horizontal slot, shown in the inset drawing, center, next page, changes

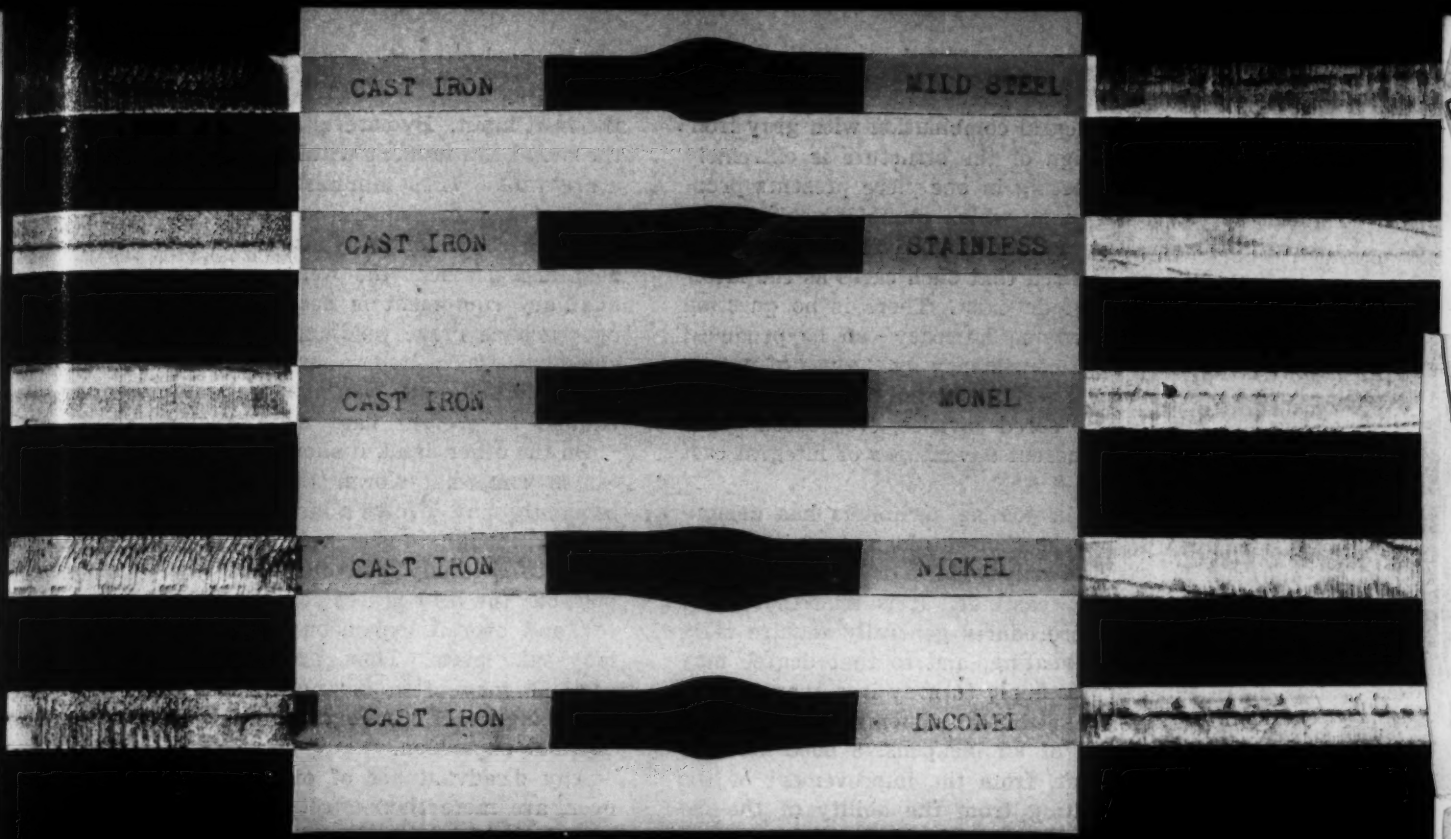


the position of the objective lens with respect to the slit mechanism to change the magnification of the system. Lenses providing 7X and 10X magnifications, seen in the photograph, can be rotated around the spot of light into a convenient position for either right or left-hand use. Heat from the light source is dissipated by a well ventilated ball-shaped housing which provides a comparatively large volume of air space around the lamp. The unit is made by Bausch & Lomb Optical Co.

Scanner Controls Stencil Cutter

PHOTOELECTRIC scanner on the Stenafax stencil cutting machine shown, right, above, permits accurate facsimile reproduction of any page-size original material. Copy to be duplicated is wrapped around a cylindrical drum, as shown in the drawing, below, and a vinyl plastic sheet is wrapped around a second "receiving" drum mounted on the same shaft. A carriage-mounted photoelectric scanner moving along the length of the drum on a feed screw scans the original copy. Mounted on the same carriage is a recording stylus which traces over the blank stencil on the receiving drum. Amplified electrical pulses from the scanner cause the stylus to punch holes in the stencil when the scanner "sees" black space. Nylon has been used for several parts of the machine, made by Times Facsimile Corp., including the feed nut, carriage sleeves that ride on the leadscrew, electrical insulation, and gears. Styled by Henry Dreyfuss, the machine produces in six minutes a stencil comparable in sharpness to a 144-line halftone screen.





Joining Cast Iron

Development of new processes portends use of welded iron assemblies

By C. O. Burgess
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Cleveland, Ohio

GRAY iron and gray iron castings can be successfully welded if certain simple but essential practices are employed. Such a statement would appear obvious if for many years it had not been believed that there were no suitable methods of joining gray iron castings, and the use of castings in fabricated assemblies was not even considered. As a result of this belief gray iron was replaced in certain types of construction by other materials, which, although less suited to the application from other points of view, could be easily welded.

Delay in developing welding techniques peculiarly suited to gray iron was partly due to the fact that in a large number of applications the use of gray iron eliminates all need for weldments. The flexibility inherent in the casting process, particularly when this is combined with the ready castability and ultimate economy peculiar to gray iron, often makes an integral gray iron casting preferable to a weldment.

There are, however, two main cases in which joining of castings by welding may be desirable: (1) If the requirements of the part necessitate the use of

This article is based on a comprehensive bulletin entitled *Welding, Joining and Cutting Gray Iron* to be published shortly by the Gray Iron Founders' Society, 210 National City-E. 6th Bldg., Cleveland, Ohio.

Nickel-base electrodes permit welding of gray iron to dissimilar metals. Various combinations are shown in these welded samples

another metal in integral combination with gray iron, and (2) if the design of the structure is extremely intricate, so that casting in one piece presents problems to the foundryman which cannot be solved economically even by the use of good foundry practice. It should be emphasized that such cases as the latter are not common but do exist. There is no question that castings of extreme intricacy can be produced by the foundry with consistency by the use of proper gating, coring and risering. However, cost of cleaning out inaccessible cored cavities, etc., occasionally overbalances the inherent advantages of integral cast construction.

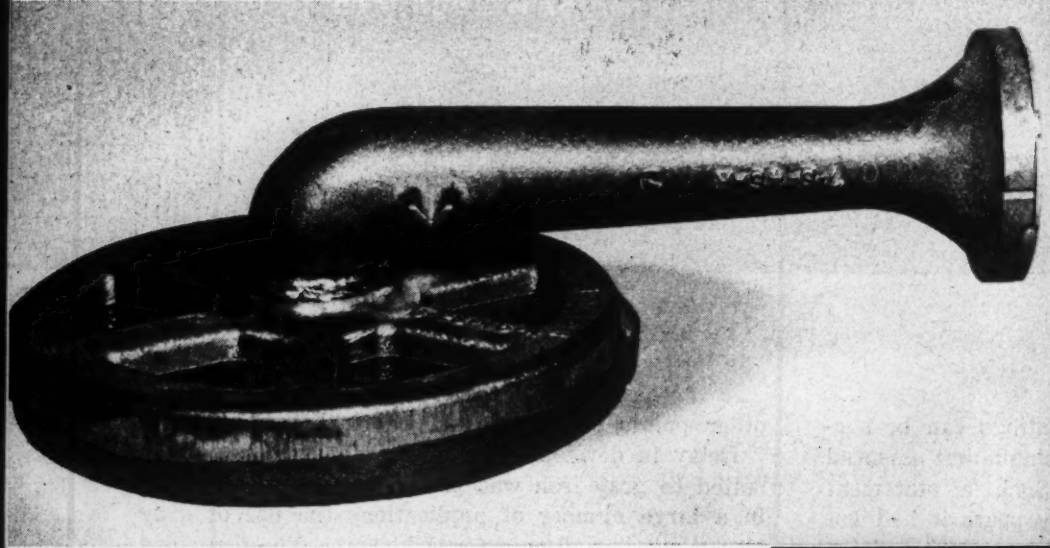
Recent progress in joining technique has demonstrated that, with proper precautions, gray iron castings can be satisfactorily welded or joined to other metals and to other castings. It is true that these approved welding procedures generally require skill, special rods or preheating, and to that degree may be more expensive to apply to gray iron than to mild steel. Nevertheless, ultimate economy frequently results from the use of an inexpensive base material and, more important, from the improvement of the final product resulting from the ability of the designer to freely employ the valuable qualities of gray iron wherever they are needed.

GAS WELDING: There are certain advantages of the oxy-acetylene process which render it particularly valuable for the welding of gray iron. The most important of these advantages is the ability to control the heat input. By careful manipulation of the torch, the metal can be kept within a fairly narrow temperature range, thus minimizing the danger of superheating and consequent run-off of metal. Furthermore, the torch may, in many cases, be used to preheat and postheat the weld, so that a minimum of auxiliary equipment is necessary. If the process is one such as braze welding, in which the base metal should not be melted to any appreciable degree, oxyacetylene welding can insure a temperature low enough to prevent base metal fusion.

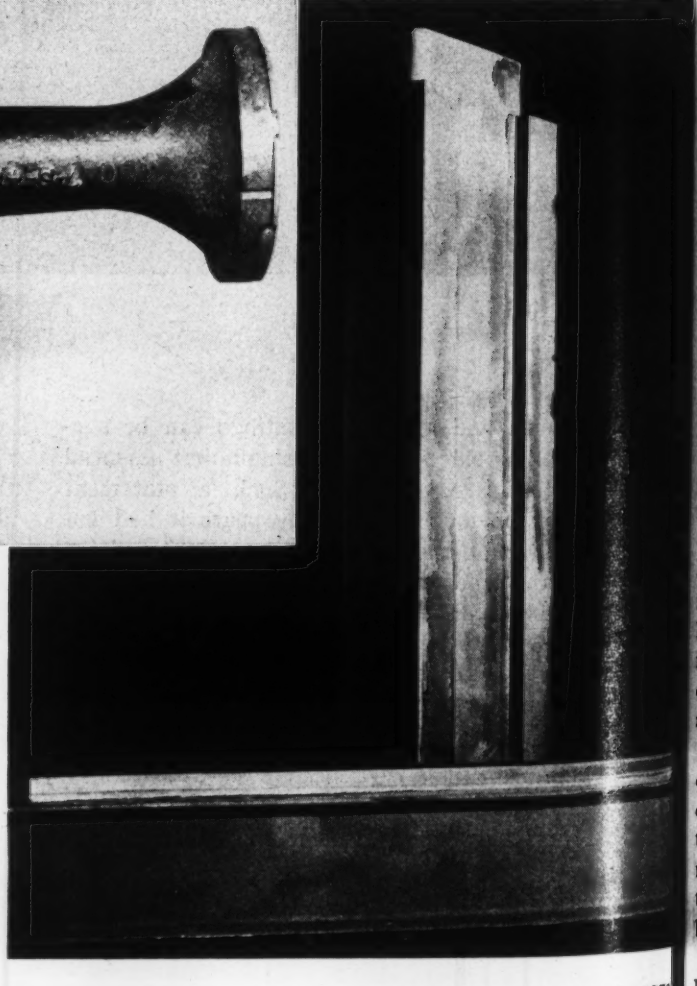
On the other hand, it should be noted that the process is somewhat slower than arc welding and consequently may involve a larger labor charge. Furthermore, although in gas welding the temperature can be more carefully controlled and local preheating is possible, the heat is less concentrated and more heating and overall expansion of the surrounding area may take place. Thus, preheating of large casting sections may often be more necessary to minimize the danger of cracking from stresses induced by thermal expansion.

Any disadvantages of oxyacetylene welding, however, are more than offset by its advantages to the extent that, despite the recent development of nickel and nickel-base electrodes for arc welding, gas welding is generally considered the most foolproof method of joining gray iron from the standpoint of strength, machinability and uniformity of results.

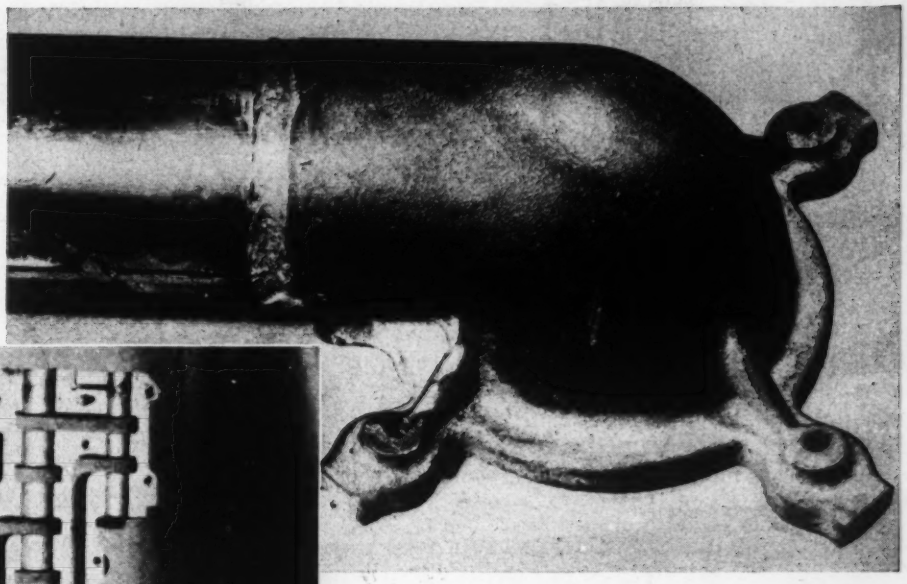
ARC WELDING: Since with this method of welding



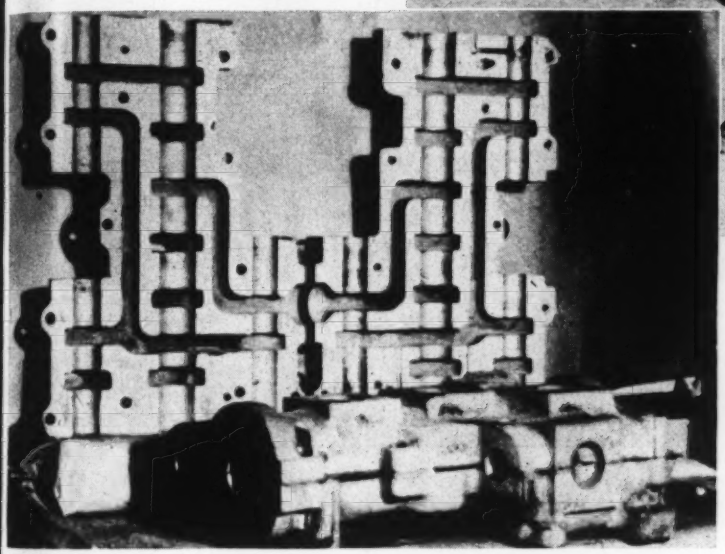
Gray iron burner, above, for a gas home heating unit after assembly by arc welding with a nickel electrode. The slotted end disk is of steel



Gray iron ways are arc-braze welded to these steel machine beds, right. A "buttering" technique is used to insure accurate alignment



Steel fuel feed line for an automatic stoker, right, arc-braze welded on a production basis to a gray iron ell



Casting of this complex hydraulic valve, left, in two parts simplifies the work of the designer, pattern maker, foundry and machine shop. Finished valve is silver alloy brazed

only a very limited area of the casting is raised to a high temperature, it is sometimes unnecessary to preheat the entire casting to eliminate expansion and contraction stresses when nonferrous or steel electrodes are employed. This avoidance of the preheating step, coupled with the fact that metal can be deposited rapidly by the arc method, means that arc welds in large castings can be completed in a comparatively short time.

Arc Welding Suitable for Any Position

Because the weld does not remain fluid for any appreciable length of time, arc welding can in general be accomplished in any position. In gas welding, however, the work cannot be welded overhead and only with difficulty at steep angles.

These general advantages have led to the use of arc welding for the joining of cast iron in a large number of applications. The limitations, arising mainly from the difficulties of temperature control, which in turn may result in hard zones, render it a process supplementary to gas welding but not a replacement of it.

BRAZING: Brazing has been defined by the American Welding Society as: "A group of welding processes wherein coalescense is produced by heating to suitable temperatures above 800 F and by using a nonferrous filler metal having a melting point below that of the base metal. The filler metal is distributed between the closely fitted surfaces of the joint by capillary attraction." Two main classes of brazing alloys are used, namely, copper or copper-base alloys, and silver-base alloys.

Brazing with silver alloys is of particular value with gray iron and is one of the processes now regularly used in production. A bond as strong or stronger than the parent metal can be formed. The process is simplified by the fact that the flow point of the alloy is only 1100 to 1200 F, considerably below temperatures involving danger of hardening or of excessive stresses from uneven expansion. Thus gray iron can be silver brazed with assurance that losses from such causes will not occur.

The cost of the silver alloy, on the other hand, is fairly high. It cannot be used economically where any filling-in of large gaps or cavities is necessary. Both for this reason and for maximum strength, the final joint clearances should be between 0.0015 and 0.005-inch. Consequently, brazing with silver alloys is confined to castings that are machined to fairly close tolerances. It should be noted that often this limitation is not serious, as evidenced in consideration given to silver brazing 4-inch diameter gray iron pipe sections. Silver brazing is naturally not employed for castings intended for high temperature applications. The economic possibilities of simplifying complicated castings involving difficult feeding or coring problems by casting them in two or more parts, and assembling the parts into a single piece by brazing, has been investigated and shows considerable promise.

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Cost Control Engineering . . . stepping stone to better design proficiency

Part 2—Cost and Design Data

COMPILATION of basic standard time data for the various production processes is an important procedure of the development group. The efficient operation of a design cost control group is dependent upon the accuracy and formation of these data. It is a continual process of improving and simplifying so that the cost engineers can readily use the data to evaluate an analysis in as short a time as possible. Since analyses cost money, it is essential that every means be made available to improve the efficiency of this work as it directly affects the project budget time to develop a product. Also, the need to minimize the delay to the designer in reaching a decision is of paramount importance.

TIME STANDARDS: The elemental time standards for processes are obtained from the studies of the methods and standards department in rough form. They are then brought before the standard data committee, which meets weekly, composed of representatives from the methods and standards, estimating, engineering (design cost control) and tool design (manufacturing research) departments. These representatives discuss and evaluate the basic information and set it up into its final form as shown in *Figs.* 5 to 8. Basically, the form of presentation is designed to maintain simplicity in use and accuracy of data. General instructions, *Fig.* 5, machine capacity *Fig.* 6, material condition, limitation of process, and elemental time standards in the form of setup, handling and operational sequences, *Figs.* 7 and 8, constitute the general form of the data.

Upon completion of the standard, the signatures of the representatives are finally obtained to certify its approval. Thus, this co-ordinated approach for cost analyses, contract estimating, shop loading, scheduling, and tooling processes is based on fundamental time standards. This also means that cost investigations will have a uniform approach to similar problems.

Primarily, the standards are developed as a 100 per cent basic time evaluation to which various controlling factors such as fatigue allowances, person

habits, efficiency factors, supervisory percentages, rework and rejection factors can be applied to formulate the true standard time value of the shop operation. The reason for this approach is that each manufacturing process has varying conditions as applied to fabricating a particular design of part.

Therefore, variations from the standards can be made to obtain the accurate overall time to perform shop operations. Typical of these modifications might be an increased fatigue factor allowed for size of part and machine operational procedure. For example, change in gage thickness from 0.040 to 0.020-inch in the drop hammer forming process indicated that the normal scrappage allowance of 5 per cent could go as high as 50 per cent in complicated light-gage parts, thereby affecting the rework and allowance percentage factor.

There are many other cases where variations can occur and must be applied to the basic standard. It is felt that this approach to the use of standard data provides the cost engineer with a better means of evaluating the cost of comparative designs.

To what extent the fineness of the developed standard data is to go depends again on the degree of accuracy desired in cost analyses. At Martin, the attempt has been to reach a medium level of elemental time standard breakdown, making allowances that only trained and experienced personnel will use the data and apply it with sound judgment, realizing that each elemental standard is composed of variables that must be considered in the application to an operation.

By the use of standards in solving a design-cost problem, a proper factual approach is achieved. The cost engineer has basic facts to explain to the designer the reasons behind costly design. In turn, the designer respects the analyst and finds that the decision is not just a guess or something pulled out of the air. Also, any time a problem is broken down into its elements the chances of mistakes or serious errors are greatly reduced. Such breakdowns definitely show where the designer as well as the cost analyst can justify the causes that are making one design more costly than another.

Pocket Manual Developed

As a further aid to the project cost control engineers, we have developed a 4 by 8-inch pocket type standard data manual which can be readily carried around. These standards are a simplified and condensed form of the original basic data. With a short form manual such as this the project cost control engineer can quickly provide simple cost decisions to the designers at the drafting boards as he is moving through the engineering department. A tabulated record of all the "quicky" decisions is maintained for reference check-back purposes.

This manual, besides the time standards, includes: labor cost factors, learning cycle percentages, and paperwork costs; formulated casting, forging and raw material prices; and fastening cost data.

As can be seen, the organization and accumulation of time and cost data are a continued effort of this development group and important in an efficiently functioning design cost control unit in the engineering organization.

PROCESS BULLETIN DATA: Organized process reference material and process cost information are essential requirements necessary to assist the designer and cost engineer in evaluating a design problem with reference to the available manufacturing facilities.

The development of process cost evaluation data as shown in *Fig.* 9 is another example of the type of work accomplished by the development group. This comparative process summary of a flap nose rib, *Fig.* 10, indicates to the engineer a variety of available processes to fabricate this part. It not only shows the type of processes but also indicates the quantities at which the various processes take effect economically. This ultimately affects the design requirements for the part to facilitate the most economical process selection. The method of presentation in this composite form covering quantity costs, process type and discussion provides the designer with convenient preliminary design information.

Cost and Time Data Linked

Development of the cost data is in turn linked with the standard time data of each manufacturing process as has been previously discussed. With this available back-up data the cost engineer can readily investigate any variations of the process that may be incurred by variable design requirements.

Along with the process cost evaluation data sheets, the drafting procedures group has developed process reference material as shown in *Fig.* 11. This type of bulletin information provides the designer with specific process design data. The process description covers such pertinent information as:

1. Equipment—size, limitations, working dimensions
2. Advantages and disadvantages of processes
3. Design information—tolerances, fits, characteristics
4. Materials applicable
5. Parts most applicable
6. Special considerations.

A detailed explanation of this information under these basic headings is clearly outlined in the pages of each bulletin as shown in *Fig.* 11. Our experience with designers is that the ever-increasing pressures of reducing design time make it essential to have available process design information in the most accurate and simplified form. The engineer, by reading and observing process techniques, acquires a general knowledge of the processes, but it is almost impossible to remember all the details in regard to design requirements. When supplied with this type of data, as well as process costs, the engineer will appreciate the resultant time-saving procedures in determining the most economical process or processes to do the job.

Design bulletins such as Comparative Cost of Materials, Comparative Costs of Standard Parts, Design for Economy, and Design Histories have been developed for the designer. In the article, "Design Economics", MACHINE DESIGN, July 1950, the author presented a detailed discussion of the contents of each

INSTRUCTIONS FOR USE OF DRILL PRESS STANDARDS

The drill press standards are shown on the attached sheets in nine tables:

Table #1. Drill press set-up times.

Table #2. Handling time for template jobs or no fixture jobs.

Tables #3, #4 & #5. Handling time for fixtures having permanent and/or removable bushings.

Table #6. Burring drilled holes.

Table #7. Countersinking.

Table #8. Extra tool change allowance.

Table #9. Drilling or drilling and reaming run time.

Table #1 - The set-up times cover three types of drill presses used in the GLM Co. Machine Shop: Allen, Upright and Radial. Set-up values for the Allen and Upright drill presses vary for jobs with fixtures or without fixtures.

Table #2 - The handling time shown in Table #2 shall be used in addition to the run time on Table #9, for jobs with templates or for jobs with no fixtures.

Tables #3, #4 & #5 - The handling time shown in Tables #3, #4 & #5 shall be used in addition to the run time on Table #9, for jobs having fixtures with permanent and/or removable bushings. The size of the part is in the upper left-hand corner of the table.

Table #6 - Burring time for drilled holes is shown in Table #6.

Table #7 - The handling time in Table #7 is per piece, but the run time is per countersink.

Table #8 - Additional tool allowance is given in the run time whenever the number of Tools (drills, reamers, spotfacers, taps, etc.) exceeds two (2) on the Allen drills or one (1) on the Radials and Uprights since this condition necessitates a tool change in the chuck on each piece.

Table No. 9 - The drilling run time shown in this table covers aluminum and steel. The column on the left gives the depth of the hole drilled in increments of 1/8". The letters "D" and "D and R" represent "Drilling" and "Drilling and Reaming" respectively.

The eight remaining columns are for the drill diameters ranging from 1/4" diam. to 2" diam. for aluminum and steel.

Use the steel drilling time to spotface, counterbore or tap aluminum; double the steel drilling time to spotface, counterbore or tap steel.

"No Fixture" jobs must include center drilling time when using drill sizes 1/4" or over.

If dimensions for hole diameters, locating of holes or distance between holes specify close tolerances of ±.002, add 20% to the over-all time.

Machine time includes:

(a) Drill point clearance.
(b) Advancing and withdrawing of drill.
(c) Cleaning drill every depth increment equal to the drill diameter.

Note:- Fatigue and Personal allowance not included in tables on succeeding pages.

Fatigue - 20%

Personal - 5%

Table 1

DRILL PRESS SET UP TIMES

MACHINE	WITH FIXTURE	WITHOUT FIXTURE
Allen	12.0	20.0
Upright	23.0	35.0
Radial	46.0	46.0
Burring	-	2.0

Table 2

HANDLING TIME

	Template Jobs and No Fixture Jobs	Center Drill	No Center Drill
No Clamps	3 X 3	.62	.31
Clamps	8 X 8	.87	.56
	16 X 16	1.25	.95

Table 3

HANDLING TIME

3X3 Removable Bushings No. of Holes/Pc.

Permanent Bushing No. of Holes Per Pc.	0	1	2	3	4	5
0	--	.91	1.24	1.58	1.91	2.24
1	.64	.98	1.31	1.64	1.97	2.30
2	.70	1.04	1.38	1.70	2.04	2.36
3	.77	1.10	1.44	1.76	2.10	2.44
4	.83	1.18	1.50	1.84	2.16	2.50
5	.89	1.24	1.56	1.90	2.23	2.56
6	.97	1.30	1.63	1.96	2.29	2.63
7	1.03	1.37	1.70	2.03	2.36	2.69
8	1.09	1.43	1.76	2.09	2.43	2.75
9	1.16	1.49	1.83	2.15	2.49	2.81
10	1.22	1.55	1.89	2.23	2.55	2.89

Table 4

8 X 8 HANDLING TIME

Removable Bushings No. of Holes/Piece

Permanent Bushing No. of Holes Per Pc.	0	1	2	3	4	5	6	7	8	9	10
0	--	1.62	1.96	2.31	2.66	3.00	3.35	3.70	4.04	4.39	4.75
1	1.34	1.70	2.05	2.39	2.74	3.09	3.43	3.78	4.13	4.47	4.82
2	1.42	1.77	2.12	2.47	2.81	3.17	3.52	3.86	4.21	4.56	4.90
3	1.50	1.86	2.21	2.55	2.90	3.24	3.59	3.94	4.28	4.64	4.99
4	1.59	1.94	2.29	2.64	2.98	3.33	3.68	4.02	4.37	4.71	5.06
5	1.66	2.02	2.36	2.71	3.07	3.41	3.76	4.11	4.45	4.80	5.15
6	1.74	2.10	2.45	2.79	3.14	3.49	3.83	4.18	4.54	4.88	5.23
7	1.83	2.18	2.53	2.88	3.22	3.57	3.92	4.26	4.61	4.96	5.30
8	1.91	2.26	2.60	2.96	3.31	3.65	4.00	4.35	4.69	5.04	5.39
9	1.98	2.34	2.69	3.03	3.38	3.73	4.07	4.43	4.78	5.12	5.47
10	2.07	2.43	2.77	3.12	3.47	3.81	4.16	4.50	4.85	5.20	5.54

Table 5

16 X 16 HANDLING TIME

Removable Bushings No. of Holes/Piece

Permanent Bushing No. of Holes Per Pc.	0	1	2	3	4	5	6	7	8	9	10
0	--	3.48	4.08	4.70	5.31	5.93	6.54	7.16	7.77	8.38	9.00
1	2.96	3.83	4.44	5.06	5.67	6.28	6.89	7.51	8.13	8.74	9.36
2	3.31	4.18	4.80	5.41	6.03	6.64	7.26	7.86	8.48	9.09	9.71
3	3.66	4.54	5.16	5.76	6.38	6.99	7.61	8.22	8.87	9.45	10.06
4	4.02	4.89	5.43	6.12	6.74	7.39	7.96	8.58	9.22	9.81	10.42
5	4.38	5.25	5.86	6.48	7.09	7.71	8.32	8.94	9.58	10.16	10.77
6	4.74	5.61	6.22	6.84	7.44	8.06	8.67	9.29	9.93	10.52	11.13
7	5.09	5.96	6.57	7.19	7.80	8.42	9.03	9.68	10.29	10.87	11.49
8	5.44	6.32	6.93	7.54	8.16	8.77	9.39	10.03	10.65	11.22	11.84
9	5.80	6.67	7.29	7.90	8.52	9.12	9.74	10.38	11.00	11.58	12.20
10	6.15	7.02	7.64	8.25	8.87	9.48	10.10	10.74	11.36	11.94	12.55

Table 6

BURRING DRILLED HOLES

Size	# of Holes 1	# of Holes 2	Each Addi'l. Hole
3 X 3	.13	.19	.08
8 X 8	.27	.36	.09
16 X 16	.58	.69	.12

Table 7

COUNTERSINKING

Size	Handling	Run Time Alum.	Run Time Steel
3 X 3	.23	.08	.16
8 X 8	.38	.08	.16
16 X 16	.62	.08	.16

Table 8

EXTRA TOOL CHANGE ALLOWANCES	ADDITIONAL RUN TIME/TOOL
Allen Dr. Press - Each Add'l. Tool Above Two (2)	.15
Upright & Radial - Each Add'l. Tool Above One (1)	.23

DRILL PRESS MACHINE TIMES IN DECIMAL MINUTES

TABLE #9 -

DEPTH DRILLED IN 1/8" INCREMENTS	DRILL DIAMETER ALUMINUM 1/4"	5/8"	1"	2"	STEEL 1/4"	5/8"	1"	2"
D 2	.14	.13	.13	.18	.15	.20	.30	.65
D & R 2	.20	.18	.19	.24	.22	.29	.41	.84
D 3	.24	.15	.15	.19	.27	.27	.37	.73
D & R 3	.32	.22	.22	.26	.36	.36	.54	1.01
D 4	.27	.18	.18	.21	.32	.34	.42	.82
D & R 4	.36	.25	.25	.28	.40	.45	.60	1.18
D 5	.29	.20	.18	.22	.35	.35	.48	.91
D & R 5	.39	.28	.28	.32	.46	.46	.70	1.33
D 6	.40	.22	.21	.24	.46	.38	.55	.99
D & R 6	.50	.34	.32	.34	.59	.60	.79	1.48
D 7	.43	.32	.23	.25	.52	.56	.61	1.08
D & R 7	.55	.43	.34	.37	.64	.75	.88	1.65
D 8	.54	.35	.24	.28	.63	.60	.67	1.18
D & R 8	.67	.46	.36	.39	.78	.82	.98	1.83
D 9	.57	.36	.27	.28	.67	.67	.73	1.24
D & R 9	.75	.54	.43	.46	.82	.88	1.08	1.98
D 10	.60	.39	.28	.32	.71	.73	.80	1.35
D & R 10	.80	.58	.46	.48	.88	.95	1.18	2.15
D 11	.64	.40	.32	.33	.77	.78	.86	1.43
D & R 11	.84	.60	.50	.53	.94	1.03	1.28	2.31
D 12	.69	.49	.33	.35	.88	.81	.93	1.52
D & R 12	.89	.69	.53	.55	1.05	1.18	1.37	2.47

These times are for drilling one hole the respective depth shown in the first column. For multiple number of holes multiply the time by the number of holes.

When drilling steel heat treated over 150,000 p.s.i. double the times given for steel.

Fig. 5—Above—Elemental time standards for drill-press operations giving general instructions

Fig. 6—Above, right—Page 2 of drill-press time standards general instructions

Fig. 7—Right—Page 3 of drill-press time standards giving tabular data on various machines and operations

Fig. 8—Left—Page 4 of drill-press standards giving data on drilling time

PROCESS COST EVALUATION

NOSE RIB - FLAP

MANUFACTURED IN LOTS OF 25 PARTS PER LOT FOR QUANTITIES OF 25 TO 500. (MODEL P4M-1)

PROCESS	TOOL & DIE COST (DOLLARS)	LABOR 3/10 HRS.	LABOR 3/17 HRS.	UNIT MAT'L. COST (DOLLARS)	UNIT COST INCL. LABOR, TOOLING & MAT'L. (DOLLARS) 1	5	25	50	100	500	SEE NOTE NO.
HYDRO-PRESS	103	1.77	.27	.24	117	25	6.17	4.02	2.88	2.25	1
DROP HAMMER	202	3.20	.24	.30	361	73	15.80	8.88	5.39	3.94	2
MAR-FORM	337 961	2.33	.12	.24	143	29	6.40	3.82	2.50	1.53	3
STEEL DRAW DIE	126 225	1.79	.10	.24	823	165	33.58	17.31	9.15	2.67	4
STRETCH FORM	810										
YODER HAMMER											
HAND FORM	99 180	1.49	1.17	.24	117	29	13.86	9.96	7.82	6.38	5
SPINNING											
OV											

NOTES:

1. Flanges must be fluted because rubber does not compress material sufficiently to prevent excessive wrinkles. Flutes restrict rivet spacing and may be undesirable from a stress viewpoint. Max. gage that can be fluted is .064. Most economical method up to 50 parts. The $103.00 tool cost includes a masonite die for 100 parts. The $202.00 tool cost includes steel die for 500 parts. For this quantity the steel die is cheaper than the masonit die which must be replaced after approximately 100 parts.
2. Smooth flanges formed. Life of soft metal dies approx. 100 parts. Special notch die required. All flanges must be 90° or open angle. Tool Cost $337.00 includes one die set for 100 parts and $961.00 tool cost includes five (5) die sets for 50 parts.
3. Cannot be formed due to size of part exceeding working area of present mar-form equipment. Cost presented for check purposes only. Most economical for 50 or more parts. Smooth flanges - no hand work. Tool cost $126.00, includes masonite die for 100 parts. Tool cost $225.00 includes steel die for 500 parts.
4. Smooth flanges formed thus eliminating disadvantages of flutes. Expensive mating dies make this method prohibitive for small quantity production.
5. Smooth flanges formed. Cost of wood block is approx. half that of a steel block but must be replaced after approx. 7 parts. For 15 or more parts, the steel block is cheaper. Tooling cost $98.00 includes one wood block for 5 parts and the $180.00 tooling cost includes a steel block for 25 to 500 parts. Larger expenditure of man hours per part results in lower production rate.

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Fig. 9 — Right — Process cost evaluation bulletin data -indicating processes and costs for producing a typical part

PROCES

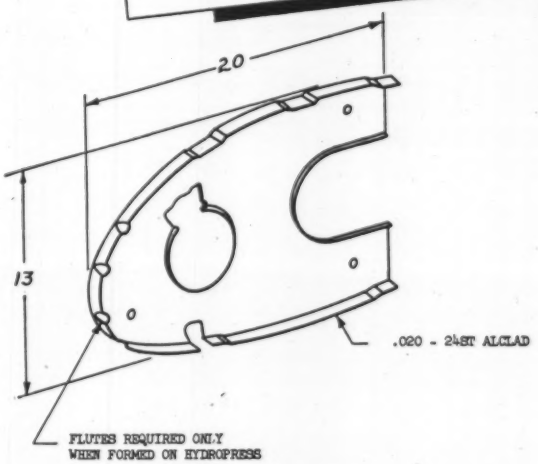


Fig. 10—Left — General design specifications for the flap nose rib covered in data of Fig. 9

bulletin and the procedures used to create the necessary design information.

To emphasize the value of design bulletins and other references developed to establish a guide to more effective design techniques, this itemized 14-point program is suggested:

1. Consider carefully any deviation from the company's manufacturing facilities. However, when conditions dictate, follow most economical plan
   (a) Review production design process information
2. Know the advantages, disadvantages and limitations of the equipment
   (a) Review process and drafting design data
3. Design to the proper process techniques; *minimize* the use of exceptional capabilities in processes
4. Think carefully before specifying untried or experimental processes. Deviate only when unusual situations exist—and time restricts immediate tests
5. Learn practical economical methods by a study of drafting procedures, production design cost bulletins, standard process and manufacturing techniques
6. *Develop a comparative technique of designing.* Think of various methods to achieve the same functions. Upon completion of comparative designing, consult the design cost control engineer to analyze and determine which method would give the most economical design to manufacture
7. Always give design consideration for *the quantity* of the order under contract. Don't always use the general fitting criteria—machine bar stock. See if a welded fitting will suffice
8. Become design check list conscious by consistently asking the ABC's of design
   (a) Before designing a part ask:
   Do you need it—can you eliminate it?
   When is it used—how long must it last?
   What specifications must be met?
   Where does it go?
   Is it easy to install?
   Is it easy to use?

PAGE 2

PRODUCTION DESIGN BULLETIN

DESIGN FOR PRODUCTION

PROCESS

THE GLENN L. MARTIN CO. NOVEMBER 15, 1949. BALTIMORE, MD.

MARFORM

INTRODUCTION

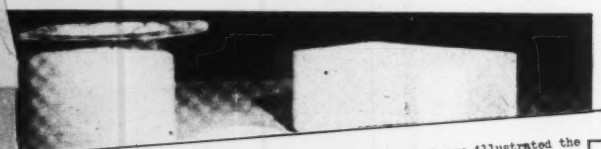
The most modern sheet metal forming machine in use at the Glenn L. Martin Company is the Marform machine. The Marform machine was developed and built by this Company to meet the needs of the aircraft industry for fast, accurate and economical sheet metal forming.

PROCESS DESCRIPTION

The Marform machine is installed in a hydraulic press as a unit. One template & male die set is required to form most aircraft detail parts. The die is secured in position on the base of the Marform Unit. Around the die is placed a template to support the material blank while it is being formed over the die.

After the forming operation is complete, pressure on the ram is released and it returns to its original "up" position. Means are provided to then automatically return the template to its original position, thus stripping the part from the die. The machine is now ready for the next forming operation.

The principal feature responsible for the success of the Marform process is the precision control of the pressure curve for the forming cycle of the part. This control of the pressure enables a part to be formed free of wrinkles and reduces springback to a minimum.



EQUIPMENT

WORKING DIMENSIONS & DATA

Max. Clearance for Part Loading & Unloading	8"
Max. Stroke	8"
Rubber Pad Working Area	28" x 31"
Bed or Max. Die Size	24" x 27"
Capacity in Tons	3500
Max. Working Pressure	7000 P.S.I.

LIMITATIONS

Min. Gage
.020 Cups, Nose & Tail Ribs (Shallow Sections)
.032 Boxes

Max. Gage
.375 SO Aluminum
.125 Mild Steel
.064 Stainless

Max. Blank Size 28" x 31"
Max. Depth of part
1 x Dia. on 1st. Operation
1 1/2 x Dia. on 2nd Operation

ADVANTAGES

It will form sheet metal to compound curvatures and with deep drawn flanges in a manner to preclude wrinkling of the metal during the forming operation.

The Marform process permits deeper draws than is possible with conventional metal forming techniques on Aluminum Alloys.

Eliminates finish forming by hand on severely formed parts of continuous flanges.

Several different parts, of complicated contours, each having similar pressure curves, can be formed at the same time.

Parts can be formed of varied materials and thicknesses within a reasonable range with little or no effect on tooling.

The material wall thickness in a deep drawn part retains more uniformity than that produced by die forming operations.

Surface finishes of the metal and coatings, such as some paints and plastics, are not affected by the forming operation.

Marform can produce up to 9 small parts per operation for higher production quantities.

9. Strains i... the form... are di... the piece, resulti... part... concentration.

10. This pro... makes p... such re... offers a ...reat adva... low as ...

11. Most details even th... drawn ...

12. Marform can includ... ...affles, design.

13. Makes uniform interc... ...parts ...

14. On production quantit... ...s can ... to .040 material.

15. Eliminates flutes on ... ...flanging ... layout time.

16. Forms heavier material ... ...

17. For normal parts only ... ...place to ... templats.

...MME...

1. All aluminum material ... ...

2. Parts formed by this p... ...are ... machines.

3. In addition to a punch, ...template is required fo... ...

...IP SHAPES DESI... IN...

1. The design of cup shapes ... ...the maximum blank size (2... ...24 x 27 inches.

The blank in every case ... ...

Note: The largest cup tha... ...in diameter and 8 ...

DIAMETER OF PUNCH TIMES 2...

Cups formed of 280, 380 ...

PAGE 8

4. Tolerances of all di... ...part to ±.002 on cl...

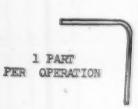
5. Design limitations ... ...be designed to form ... (example, no undercu...

6. Avoid open flanges ... ...variation between top ...

PARTS WITH DIM. LESS THAN 1/2 INCH EASILY FORMED IN ONE OPERATION

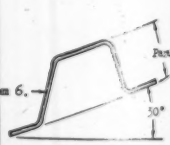
Note - closed flanges ... ...it can be removed ...

7. Parts requiring only one ... ...machine; however, where ... efficient.



1 PART PER OPERATION

Parts can be formed with ... bottom remain parallel.



...m 6. ...50°

Top & Bottom parallel & LESS THAN 30° CAN BE MARFORMED

...- Sides can be ... of para...

6 In the previous example and in the following graph are illustrated the various Marform design limitations.

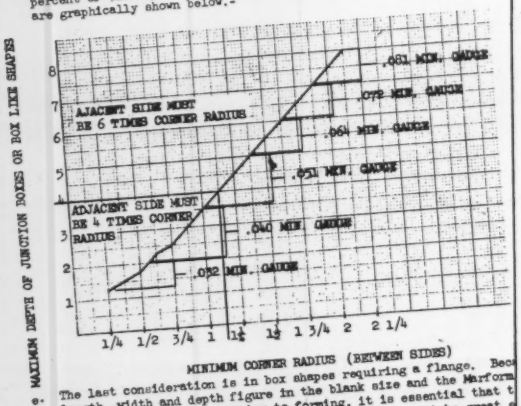
a. The bottom radii on box shapes shall be 1/2 inch where ever possible to prevent shearing of the blank on the punch.

b. The depth of the box determines the corner radius. Sample tests by Tool Engineering show boxes 1 1/4 deep require 1/4 inch radii and boxes 6 inches deep require 1 5/8 radius. All were formed with 1/2 bottom radius using 280, 380 or 6180 material.

c. After determining the critical depth and corner radius (between sides) care must be taken to allow sides large enough on the box to absorb excess material in the blank as the result of forming. As shown on the graph, boxes 4 inches deep and under with corner radii 1 1/8 and under require sides 4 times the critical corner radii.

Example - box 4 inches deep would have sides of at least 4 times 1 1/... or 4 1/2 inches.

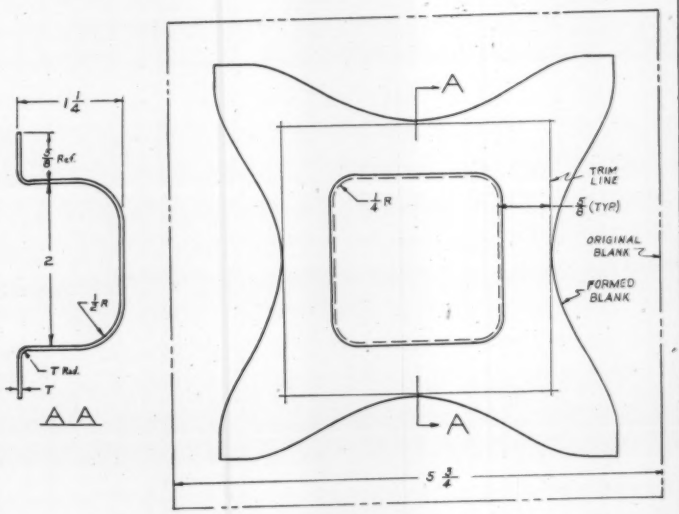
d. After having established the size of the box the next variable to establish is the material and gage to be used. Sample tests to date indicate that on 280, 380 & 6180 the minimum gage runs approximately .1 percent of the depth of the box (with .032 the minimum gage). These are graphically shown below.-



e. The last consideration is in box shapes requiring a flange. Because length, width and depth figure in the blank size and the Marform process loads the blank prior to forming, it is essential that the blank is not too big. The pressure on the blank must be great enough to exclude wrinkles in the forming area, yet not applied over too great an area to resist flowing, otherwise the blank shears on the punch. Tests to date on junction type boxes indicate the flange can never be greater than 5/8 inches at the center of each side formed to maximum depth. (See Sketch on Page 7)

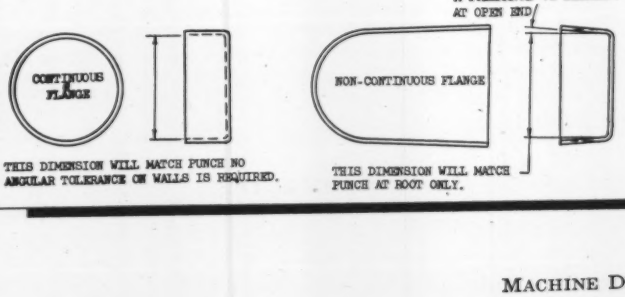
Flanges may be increased in amount equal to the difference between the developed length of the maximum draw and the part in question

PAGE 7



Box showing original blank & formed part prior to trimming.

3. In Marform parts angular tolerances can be held to ±2° on non-continuous flanges while continuous flanges will match the die.


THIS ANGLE WILL HAVE A TOLERANCE ±2 DEGREES. AT OPEN END
CONTINUOUS FLANGE
NON-CONTINUOUS FLANGE
THIS DIMENSION WILL MATCH PUNCH NO ANGULAR TOLERANCE ON WALLS IS REQUIRED.
THIS DIMENSION WILL MATCH PUNCH AT ROOT ONLY.

PAGE 3

distributed more uniformly throughout
parts relatively free of internal strain

h reduction in tooling costs that it
as well as high volume production.

rawn can be formed in one operation.

flas, & lightening holes in the regular

arts to a close tolerance.

can be trimmed in the forming operation up

aging reducing engineering and tooling

possible by other comparable methods.

ace tool is required - one punch and one

IMENTS

la formed in the SO or SW condition.

re small due to working limits of existing

ending to the Hydropress form block, a
m operations.

INFORMATION

ited by the stroke of the machine (8 inches)
he in diameter and the maximum die size

not exceed 2.34 times the punch diameter.

la formed on present equipment is 12 inches
eep.

ERAL MAXIMUM BLANK SIZE

0 material can be formed in depth equ

PAGE 4

FORMING CHART FOR 280, 380 & 6180

DIAMETER OF CUP	MINIMUM GAGE	MAXIMUM DEPTH
1	.025	1
2	.025	2
2 1/2	.025	2 1/2
3	.030	3
4	.040	4
5	.050	5
6	.060	6
7	.070	7
8	.080	8
9	.090	8
10	.100	8
11	.110	8
12	.120	8

ote- an additional forming operation will increase depth to 1

Cups formed of 5280, 2480 and 1480 material can be formed in
to 3/4 their diameter in one operation with material gages ap
1$ of the diameter with .025 the minimum gage.

FORMING CHART FOR 5280, 2480 & 1480

DIAMETER OF CUP	MINIMUM GAGE	MAXIM
1	.025	
2	.025	1
2 1/2	.025	1
3	.030	2
4	.040	
5	.050	3
6	.060	4
7	.070	5
8	.080	
9	.090	6
10	.100	7
11	.110	
12	.120	

Cups formed of 1010 (Deep Forming Quality) steel can be for
equal to 3/4 their diameter with material gages approximately 1/
diameter with .020 the minimum gage.

FORMING CHART FOR 1010 (DEEP FORMING QUALITY) S

DIAMETER OF CUP	MINIMUM GAGE	MAXIM
1	.020	
2	.020	1 1
2 1/2	.020	1 1
3	.020	2 1
4	.020	3
5	.025	3 2
6	.030	4 1
7	.035	5 1
8	.040	6
9	.045	6 3
10	.050	7 1
	.055	8

PAG

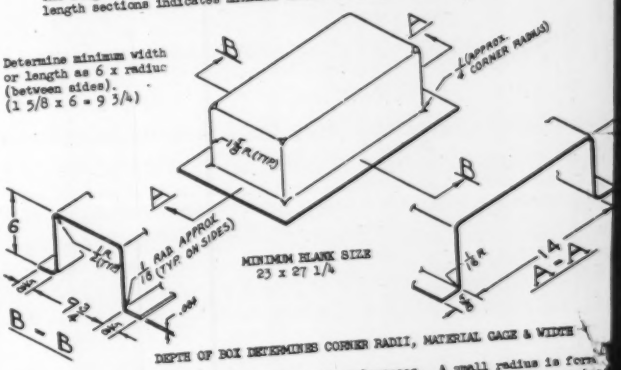
Cups of Corrosion Resisting Steel type 302 (annealed or deep forming quality) can be formed in depth equal to 1/3 their diameter in material gages approximately 1/2 of 1$ of the diameter with .020 the minimum gage.

FORMING CHART FOR CORROSION RESISTING STEEL TYPE 302

DIAMETER OF CUP	MINIMUM GAGE	MAXIMUM DEPTH
1	.020	3/8
2	.020	11/16
2 1/2	.020	27/64
3	.020	1
4	.025	1 3/8
5	.030	1 11/16
6	.035	2
7	.040	2 3/8
8	.045	2 11/16
9	.050	3
10	.055	3 3/8
11	.060	3 11/16
12		4

BOX SHAPES

2. The design of box shapes are limited by the stroke of the machine (8 inches), the blank capacity (28 x 31 inches), the maximum die capacity (24 x 27 inches). The length of the formed perimeter as taken through the largest width and length sections indicates minimum blank dimensions. (See Example).


Determine minimum width or length as 6 x radius (between sides). (1 5/8 x 6 = 9 3/4)
A
B
(APPROX. 1/4 CORNER RADIUS)
1 5/8 R. (TYP.)
6
1/4 RAD APPROX. 1/8 (TYP. ON SIDES)
9 3/4
MINIMUM BLANK SIZE 23 x 27 1/4
B - B
A - A

DEPTH OF BOX DETERMINES CORNER RADII, MATERIAL GAGE & WIDTH

Note: Radii formed at the flange has a wide tolerance. A small radius is form
in the center of each side, about one times the material gage to approxima
4 times the material gage in each corner (based on 280, 380 & 6180 material
Where this large flange radius tolerance is unacceptable for design purpose
another operation of the Marform machine using a radius forming plate will
reduce the radius in each corner.

PAGE 9

MATERIALS APPLICABLE

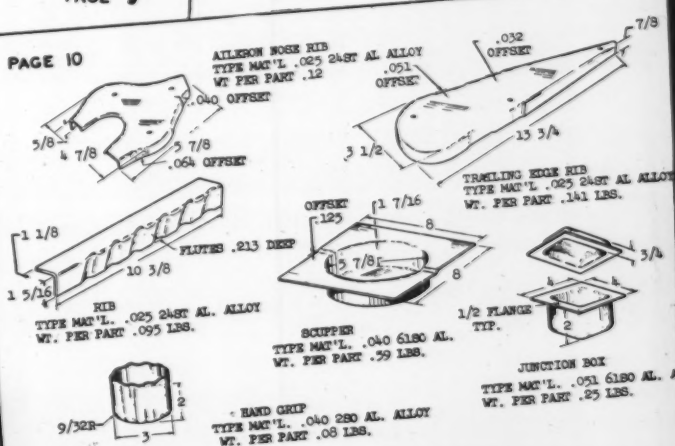
Materials in order of preference

Aluminum	Steel
2S	Deep Drawing Quality (1010
3S	1020
61S	1030
52S	Stainless Steel Type 302
301, 14S,	Stainless Steel Type 304
24S & 75S	Stainless Steel Type 321
	Stainless Steel Type 347

MOST APPLICABLE TO THIS

Nose Ribs
Tail Ribs
Small details & frames
Boxes
Cups
Pans
Angles
Corner pieces (formed as a box)

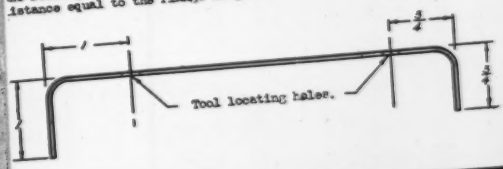
PAGE 10



SPECIAL CONSIDERATIONS

1. Often the parts can incorporate beads and flanges to increase rigidity and eliminate riveted assemblies.

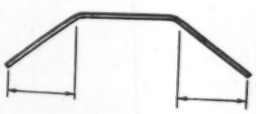
2. Locating pins required to hold the parts should never be symmetrically located about a centerline on right or left hand parts. Locating holes shall have sufficient edge distance to prevent tearing the blank during the forming operation. Set locating holes back from the flange a distance equal to the flange height.



...one incorporated in the die will be held in the ...continuous flanges such as cups, pans & boxes.

...ame as with any die forming in that parts must ...e direction and still be removed from the die.

...es which have more than 1/2 inch dimensional ...ction



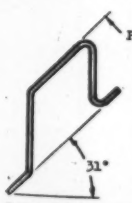
PARTS WITH THESE DIMENSIONS OVER 1/2 INCH REQUIRE SEVERAL FORMING OPERATIONS.

...formed on Marform provided the design is such that ...the die.

...d flange can easily be formed on Marform ...can be formed in pairs or sets it is more

2 PARTS PER OPERATION

...r variations up to 30$ so long as top &



Top & Bottom Paral
BUT GREATER THAN 3
CANNOT BE MARFORMED

...within limitations of item 6.

Fig. 11—Basic process reference data for designers covering Marform method of sheet metal forming. Various pages show concise clear approach to facilitate design familiarity with process

Is it easy to service?

(b) Then, in designing the part, determine:
How it can be combined
How it can be simplified

(c) And, where possible, design for:
A minimum number of simple members
Straight members, unless forming simplifies
Standard parts, shapes, sizes, dies
Maximum acceptable tolerances and finishes
Greater than minimum bends, clearances, etc.
Low-cost materials, for example 1020 vs 4130
Forming in soft material condition
Low-cost fasteners, minimum number
No closed angles or re-entrant cuts
Making part in own shop, on available equipment

9. *Individually develop the impression that you personally are operating your own business; that profit or loss made in your area is your responsibility*
10. Seek an opportunity to *follow your design in the shop.* Find out the good and bad features, difficulties and improvements, ask questions of the makers and apply these ideas in design of future parts
11. Investigate and compare designs with those of competitive companies. *Keep informed.* Check your cost engineer. He can help you
12. Use the services of representatives of tool engineering and design cost control to a maximum. Ask questions. These men are constantly on the alert for new, low cost, high quality methods and techniques of tooling up for manufacture
13. Be familiar with, then utilize, the drafting and release procedures. This will pay dividends in smooth, efficient flow of the paper work through all other departments. The most salient "check points" for the draftsman-designer are:
    (a) Observance of drafting fundamentals and conventions
    (b) Indication of quantity, material and usage of each part number
    (c) Proper handling of raw material and purchased equipment procurement
    (d) Compliance with system restrictions (designed to facilitate release from engineering and use of the drawing in the manufacturing division)
14. Realize your responsibility as an engineer. The drawing you release is the *centric of action* as a supplier of information to purchasing, manufacturing, tooling, inspection, customer, service and spares provisioning teams. This multiple usage *makes* near perfection mandatory to eliminate costly errors.

The endless search for more economical design is a continuous process of evolution requiring a constant application of promotional activities. The possibilities are tremendous. It takes but the understanding and conviction of management that engineering is the key. The right organization and policies will open the door to the relatively unexplored avenues of low-cost production.

Generator Output Controlled by Magnetic Clutch

ONE of the first applications of the new magnetic fluid clutch, developed by Jacob Rabinow of the Bureau of Standards, is shown accompanying. The unit, a Vickers Magneclutch, is used as a coupling between an induction motor and a generator for the purpose of automatically maintaining the generator speed or frequency at a constant value. The clutch excitation is varied to change the slip as the induction motor speed changes due to its own slip-load characteristic and to supply line frequency variations.

The control or excitation for the clutch is provided by a static magnetic amplifier type frequency regulator which is piloted by the frequency output of the generator.

Direct-current excitation for the generator is derived from a static magnetic amplifier type voltage regulator. This is essentially a field supply that automatically adjusts the generator field current to the value required to maintain a constant line voltage. The voltage regulator as well as the static amplifier component of the frequency regulating system are units devoid of any moving mechanical parts and are therefore inherently shock-resistant and essentially free of extensive maintenance problems.

The equipment demonstrated is a 5-kw motor-generator, 450-volt, 3-phase, 60-cycle, a-c motor connected to 120-volt, 3-phase, 400-cycle a-c generator. This system provides a means for obtaining extremely close speed and voltage regulation, both for steady-state and for transient recovery. Steady-state regulation of speed and voltage is better than one-half per cent under extreme changes of input power supply and generator load. Voltage recovery after application of full load in one step is in the order to 1/300-second. A 100 per cent load change produces a transient in speed or generator frequency of a very small magnitude (phase shift only) with recovery in approximately 1/3-second.

Design for ECONOMY

. . . demands consideration of quantities

By W. T. Minech
Production Design Engineer
North American Aviation Inc.
Los Angeles, Calif.

THE general problem of cost involves every department in a company but the factors that are under direct control of the design engineer are esign for economy in material, tooling and labor. here is another important item, not usually asso-iated with design, that might be defined as the bility to predetermine which of several possible hoices would go through the "system" the smooth-st. This is predicated on little or no difference in stimated cost, as any relatively small cost differ-nces can be quickly offset by extra paper work, in-pection, salvage action, etc. It is obvious that ex-perience can be a helpful guide to this phase.

PURCHASED PARTS AND MATERIALS COST: Standard parts or a part already in production should always be a first consideration. Purchased parts are a very important source of economy in design but should be compared with a possible new design before a decision to use is made. If the purchased part is used its choice should be made on the basis of quality, delivery and price.

The design engineer has control over raw material costs. He can specify a forging costing $1.00 per pound or a piece of sheet-steel costing $0.10 per pound. How a choice of material can affect cost is shown in *Fig.* 1. This part was originally drawn up as an aluminum alloy permanent-mold casting with slight differences to accommodate sound casting de-

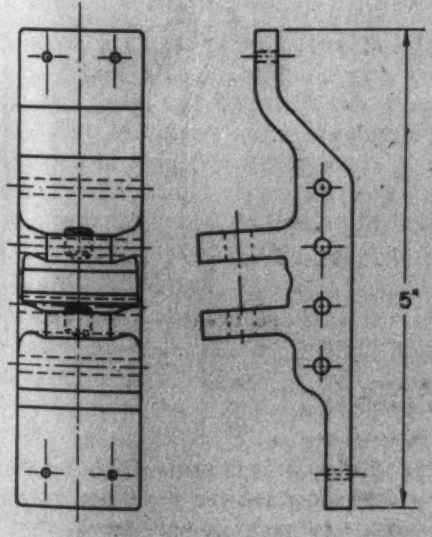
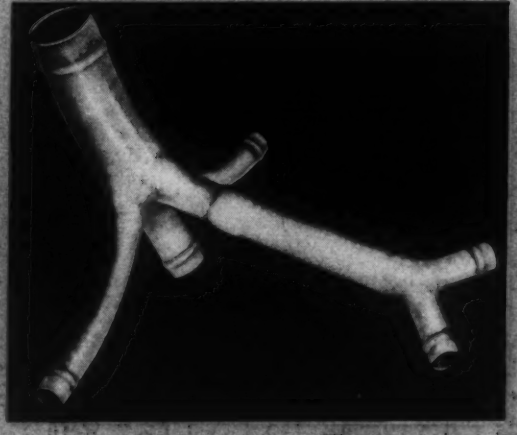


Fig. 1—Left—This type of part is ideally adapted to the extrusion process

Fig. 2—Below—Deicing duct, approximately 18 inches long overall, is fabricated over a "breakaway" plaster core which is removed



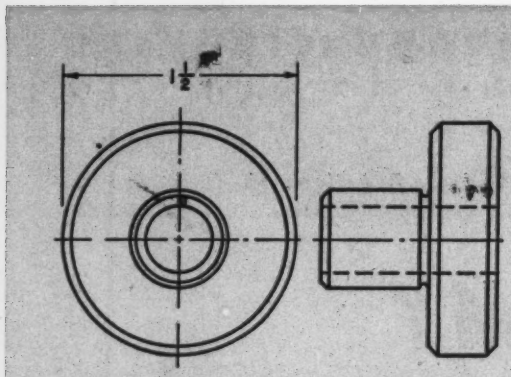


Fig. 3—Left— Since the hole has to be drilled and reamed regardless, difference in material cost is the deciding factor

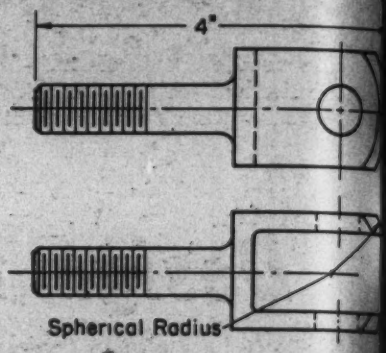


Fig. 4—Right—Round bar stock is preferred over square bar for this clevis pin

sign. Before going into production a change to a stronger material was requested. Investigation showed that a magnesium extruded shape would meet requirements and would be cheaper and lighter. The big advantage costwise was taking this part out of the Class A casting category, eliminating static testing and x-ray charges. The following is an estimated cost breakdown:

	P. M. Cstg.	Ext. Shape
Material	$ .49 (incl. x-ray)	$ .22
Labor & Burden	.33	.56
Production Cost Each	.82	.78
Pro-rated Tooling (600 pcs)	.90 (incl. static test)	.66
Total Cost Each	$1.72	$1.44

An interesting comparison because of the alternate methods of fabrication and tooling made necessary by choice of material is presented by the part in *Fig.* 2. This is a good comparison for the "plastics vs. sheet metal" problem. The part is a de-icing duct and was made of laminated-glass fabric because of quantity involved. The labor costs for this design are far more than for one of sheet metal which would have to be made of several stampings and tubes welded together. But the tooling costs for sheet metal are so high that it takes approximately 240 pieces for the metal design to be competitive. Following is a cost breakdown for 100 pieces which was the quantity involved:

	Plastic	Sheet Metal
Material	$ 1.44	$ 1.70
Labor & Burden	25.78	17.04
Production Cost Each	$27.22	$18.74
Pro-rated Tooling 100 pcs	2.25	23.50
Total Cost Each	$29.47	$42.24

Two types of parts that cause some doubt as to proper choice of material are shown in *Figs.* 3 and 4. *Fig.* 3 is a shouldered steel bushing. The correct material would be bar stock, not tubing. The small extra cost of removing the center portion is more than offset by the high relative cost of heavy-wall tubing. For the steel clevis in *Fig.* 4 there is a choice in materials of square or round bar stock. (A forging would be more economical in production quantities of 500 parts or more). Square bar would save material as well as machining but the interrupted cutting (which round stock eliminates) slows down cutting speeds in many cases so as to void any savings. However, if the clevis body were round instead of square, the round bar stock design would be considerably cheaper and no extra operations would be necessary as the flats parallel to the slot, as well as the slot, would be machined in one operation.

TOOLING COST: The cost of tooling can be kept low by proper design of parts. This is apart from the fact that a small amount invested in tocling will result in higher labor cost or, conversely, low labor costs can be achieved by spending an adequate sum on tooling. The decision in the matter depends on the expected volume of production. This factor is of prime importance in planning tooling and the method of making the part. Naturally, the final decision on type of tooling is often out of the design engineer's control but he can design with maximum economy in mind by predesign consultations with the tooling division.

The large steel hook shown in *Fig.* 5 is an unusual example of how a large amount of money spent for tooling "payed off" on small quantities. The amount of duplicating and profiling time necessary for each bar stock part is the large item of cost saved by procuring forging dies. The following figures show the break-even quantity at 13 pieces:

	Die Forging	Profiled
Material	$ 22.60	$ 51.00
Labor & Burden	51.56	338.86
Production Cost Each	74.16	389.86
Pro-rated Tooling 13 pcs	308.00	.....
Total Cost Each	$382.16	$389.86

Another type of part that presents a problem to the designer is one which involves a choice between a relatively simple casting and bar stock. *Fig.* 6 illustrates an aluminum alloy sand-cast fuel system nipple. This is not a structural part but should be leakproof. An analysis proves that a bar stock part is more economical as well as better for this application. In this instance a pattern saving resulted in a cheaper part:

	Sand Casting	Bar Stock
Material	$ .84	$ .61
Labor & Burden	1.12	1.17
Production Cost Each	$1.96	$1.78
Pro-rated Tooling 200 parts	1.30	.60
Total Cost Each	$3.26	$2.38

LABOR COST: Labor cost is controllable by the engineer as any designing toward reduction in operation time necessary to make a part would result in lower cost. Also, elimination of operations in many

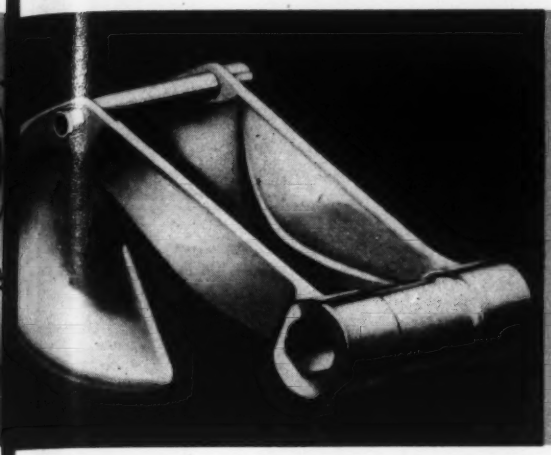


Fig. 5—Left—Catapult hook made from SAE4340 steel weighing approximately 26 lb. An unusual parting line is necessary on the forging to eliminate costly machining

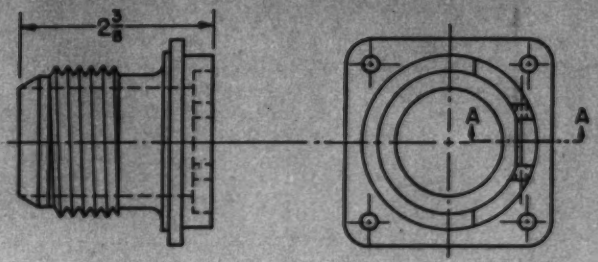


Fig. 6—Above—Because this part is made from aluminum, square bar stock is cheaper than a casting

Section A–A

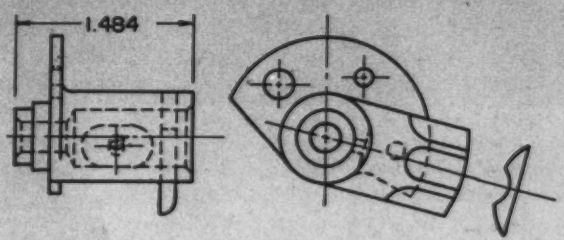
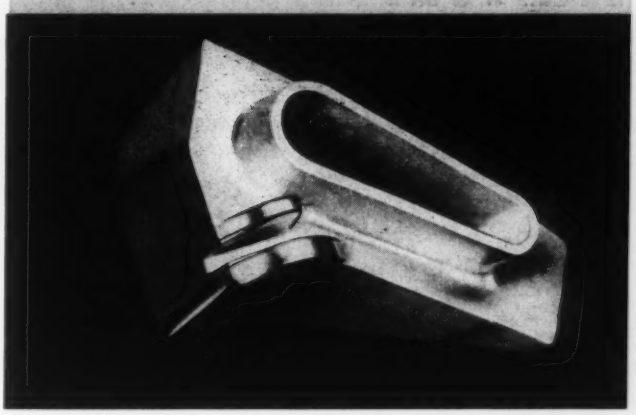


Fig. 7—Above—The "lost wax" casting process can produce at considerable savings intricate small parts such as this that compare closely with machined bar for tolerance and smoothness

Fig. 8—Below—Permanent-mold casting saves considerable machining on this part as well as produces a better part than a sand casting



cases should point toward reduced costs. This does not hold true in as many cases as does the theory of less parts-less cost . A cost analysis can clear up this type of design problem.

Following is a cost comparison between a steel precision investment casting and a piece of steel bar stock machined to shape. The casting saves all machine work except the matched holes in the flanges and grinding of two close-tolerance diameters:

	Investment Casting	Bar Stock
Material	$2.68	$ .48
Labor & Burden	.45	4.85
Production Cost Each	$3.13	$5.33
Pro-rated Tooling 275 pcs.	1.60	2.27
Total Cost Each	$4.73	$7.60

This saving in machine labor is an appreciable item as the example shows. The necessity of milling fixtures for profiling the bar stock part is eliminated in addition. The casting is shown in *Fig.* 7.

A fairly complicated aluminum alloy permanent-mold casting, *Fig.* 8, was analyzed in the design stage vs. a sand casting. This part performs several functions such as tying structural members together as well as acting as an opening for cockpit venting. In addition, several mold line contours must be held which can not be done with a sand casting without contour machining. In fact this part is not practical as a sand casting, except for small-quantity production. The casting is designated as Class A type casting and because an aluminum alloy permanent-mold casting has higher allowables than an equivalent sand casting, an advantage was gained structurewise. The following figures are based upon the anticipated quantity at time of design:

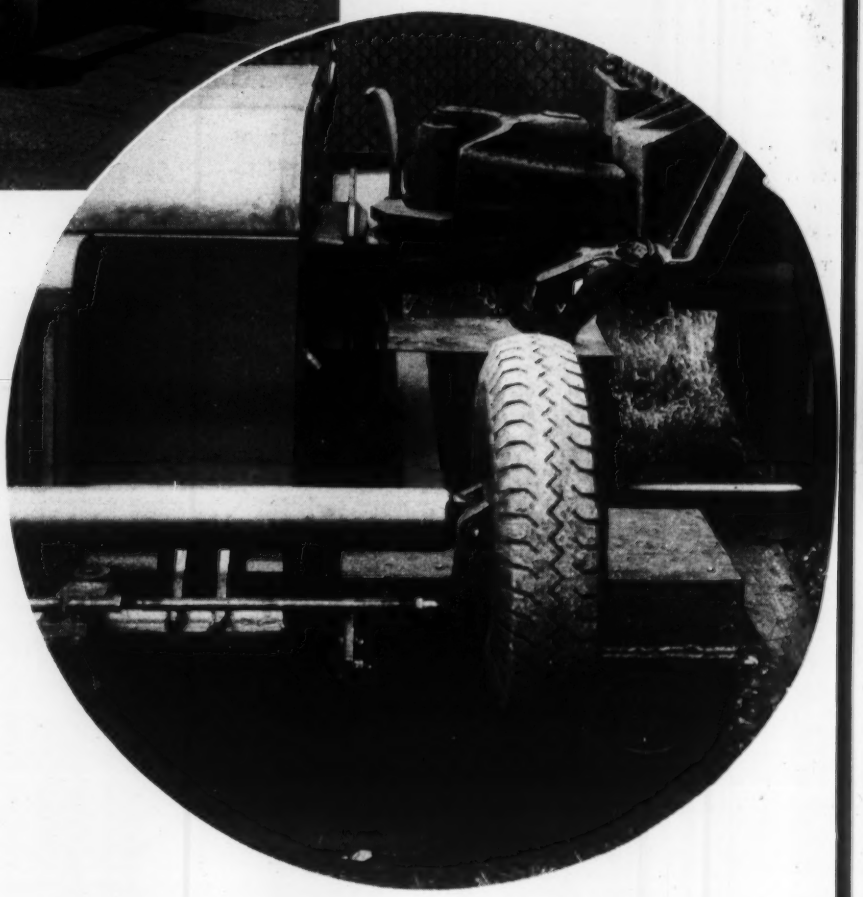
	P. M. Cstg.	Sand Cstg.
Material	$1.63	$1.80
Labor & Burden	.48	6.44
Production Cost Each	$2.11	$8.24
Pro-rated Tooling 2000 pcs.	1.22	1.19
Total Cost Each	$3.33	$9.43

COST INFORMATION: It is apparent from the examples described in this article that quantity of parts to be made is an important question to be answered before considering design. The production cost of parts is dependent to a great extent on the tooling available, but it is no economy to transfer, say, much hand work to the tooling department as tools or vice versa until the overall cost picture is known. The choice of design should be based upon facts. The designer should resist, particularly, efforts of one department to change a part to lighten its own production problems while at the same time penalizing some other department. This is a difficult decision to make and requires experience to analyze the complete problem.

So many variable factors are involved in making a considered estimate that the design engineer can not be expected to remember them. It is better to spend a little more time in preparing a design and having it right, than to rush it through and then have to make changes. Every change costs money. In addition to all the paper work, if it involves materials or dimensions, a change may result in a great deal of waste materials or the scrapping of expensive tools.

Fig. 1—Left—Trackmobile shown approaching track on road wheels prior to dropping onto rail wheels

Fig. 2—Below—Unit shown coupled to railway car. Hydraulic jack has raised Trackmobile coupling against car coupler to force Trackmobile down on rails to obtain added traction



Versatile Railcar Switcher

TERMINAL handling of railway cars—including hauling, spotting and switching—is a big and often expensive materials handling chore. One solution to the problem, developed by the Whiting Corp. of Harvey, Ill., is a small and compact, gasoline-powered Trackmobile, *Fig.* 1, weighing only 6000 pounds but developing a draw-bar pull of 7350 pounds. Unique feature of the machine is the use of two sets of wheels for either road or rail travel.

Four rubber-tired wheels for ground travel are hydraulically retracted, through the linkage partially seen in *Fig.* 2, in positioning the Trackmobile for track operation on its four standard AAR steel wheels. The operation of coupling to any standard railway car is controlled from the driver's seat and does not require an additional man. A hydraulic jack raises the special Whiting coupler against the standard car coupler and forces the Trackmobile down on the rails.

Fig. 2 shows the coupler in the engaged position. A portion of the rail car weight is thus transferred onto the unit, resulting in the unusually high draw-bar pull available. With the road wheels retracted, the "locomotive" will move through any door that will pass a standard rail car; when on road wheels, it clears any door suitable for motor trucks.

Power plant is a Jeep gasoline engine, developing 60 bhp at 4000 rpm, connected to a four-speed transmission through a single-plate, heavy-duty 9-inch diameter clutch. The transmission uses standard automotive selective shifting to give all four speeds in either direction. No-load maximum road speed is 25 mph; rail speeds vary from 1.5 mph with 7350 pounds draw-bar pull in first gear to 9.0 mph with 1100 pounds in fourth gear.

Mechanical Properties of Metals

How are they measured? What do they mean?

By H. W. Gillett
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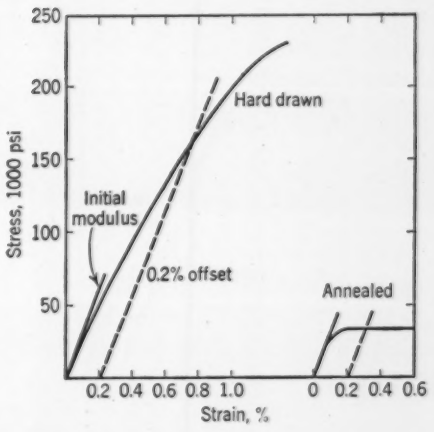

Fig. 1 — Stress-strain diagrams for hard-drawn and annealed 18:8 stainless steel. (From McAdam and Mebs[1])

MECHANICAL properties of metals and alloys are measured by certain conventional tests. Despite the fact that a numerical figure is obtained in each of the tests, very few of the data are directly applicable to design. This is because service behavior does not utilize the exact property thus measured, or at least that property is not the dominant one that determines its utility. With the sole exception of the modulus of elasticity, not a single one of the values can be relied upon as a direct measure of even a single factor of suitability; all the others offer is a qualitative appraisal of an attribute that may create an expectation of a certain behavior but does not insure it. They add to the metallurgist's understanding of the sort of material he is dealing with, but they do not lend themselves to the engineers' computations.

TENSILE TEST: Chief conventional criterion of the behavior of metals and alloys is the tensile test. Because tensile figures are widely cited as though they determined the relative values of different alloys, it is worth while to examine the test and the meaning of its figures in some detail. In this test a specimen, usually a round one 0.2 sq in. in area (0.505 in. diameter) or a flat one, often of still smaller area, is pulled in a testing machine. As stress is applied, the specimen stretches, first in essentially elastic fashion; that is, if the stress is released the specimen comes back to its original length. In extremely brittle materials there is only elastic action clear up to fracture. If the unit stress is plotted against the strain, it produces a stress-strain diagram which, in this case, is just a straight line. For most metallic materials it is very close to a straight line so long as the action is wholly elastic.

Proportional Limit: In less brittle and in ductile materials this straight line sooner or later starts to curve, because plastic action is beginning, and if the stress is released the specimen retains some elongation, i.e., "permanent set." The point at which the curvature begins and the straight-line proportionality ceases, i.e., the unit stress at which the action ceases to be wholly elastic, is termed the *elastic limit* or the *proportional limit*. On an accurate stress-strain diagram, plotted to large enough co-ordinates, this start of plastic action is made evident by the increasing curvature as the stress increases, but the exact stress at which a tiny amount of plastic deformation appears is difficult to determine. The apparent proportional limit depends as much on the sensitivity of the meas-

This article is based on an early chapter from Dr. Gillett's new book completed shortly before his untimely death last year. His shrewd appraisal of conventional tests is a timely reminder that their significance in relation to expected conditions of actual service should be critically questioned

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uring equipment as on the properties of the specimen. Hence results from different laboratories are likely to disagree, and handbook values for proportional limit need to be viewed with caution.

Moreover, supposedly duplicate specimens of some alloys in some conditions have marked differences in proportional limit. McAdam and Mebs,[1] using precise equipment, found on the basis of a permanent set of 0.001 per cent that for a hard-drawn 18:8 stainless steel of 18.8 chromium, 9.4 nickel, 0.06 per cent carbon, the corresponding stress varied from 6500 to 35,000, with an average of 19,000 psi. When the permanent set was increased to 0.02 per cent, all the specimens showed about the same corresponding stress—about 140,000 psi.

Yield Strength: Most structures can stand a tiny bit of permanent deformation, and so it is customary to compare metals on the basis of the stress that produces 0.2 per cent permanent set. This is called the "yield strength." Sometimes a smaller or a greater permanent set is allowed, and so one needs to know whether the yield-strength figure cited is based on the usual or some amount of permanent set. The slope of the straight portion of the diagram depends on the nature of the metal; some metals deflect more than others under the same load, as mentioned later. The yield strength is determined from the stress-strain diagram by drawing a line of the same slope as that of the straight portion but offset from it by 0.2 per cent or by whatever other amount of permanent set is taken as the criterion. *Fig.* 1, from McAdam and Mebs,[1] shows this method (applied to a different lot of 18:8) in the hard-drawn and the annealed conditions.

The gradual curvature of the stress-strain diagrams of *Fig.* 1 is met in most commercial alloys, with the exception of soft, low-carbon steel in which there is an abrupt jog when the straight line is passed. In that case there is a *yield point* which closely corresponds to the yield strength of the offset method. In such steels, the yield point is evident by the drop of the beam in the tensile test; the specimen elongates without increase in stress. Ordinary unstabilized low-carbon steel has its stress-strain diagram altered by even a very tiny amount of cold work, the proportional limit is lowered, and the jog is eliminated. Upon lying around, the unstabilized material ages and the jog returns.

Modulus of Elasticity: Slope of the elastic, straight-line portion of the curve gives the *modulus of elasticity,* a measure of the springiness of the metal. The moduli show the deflections that different metals will assume under like loads, as long as those loads are within the elastic range and do not produce permanent set. At room temperature, a given alloy will have about the same modulus whether it has been made strong by heat treatment or brought to its weakest condition by annealing; thus, if the alloy is not to be stressed above the proportional limit, the strong and the weak conditions display the same spring action. Of course, for actual springs the strong condition is

[1] References are tabulated at end of article.

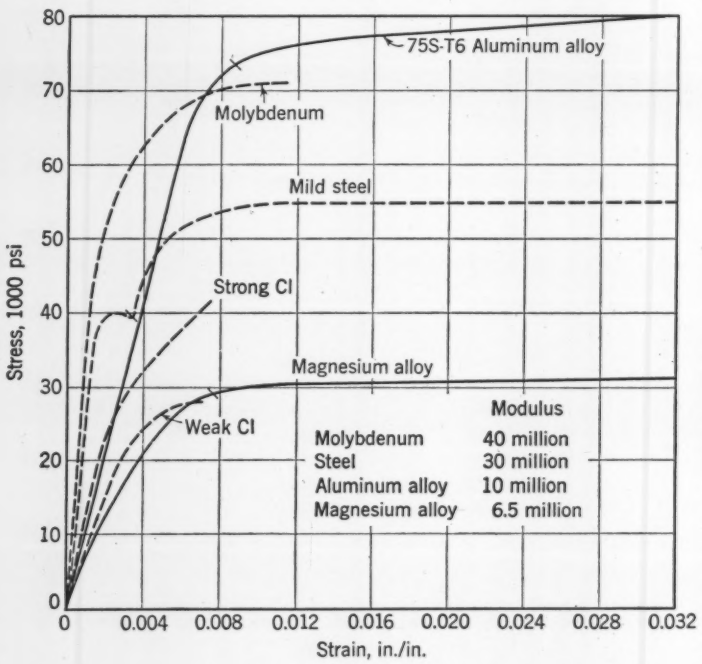


Fig. 2—Above—Stress-strain diagrams of some metals

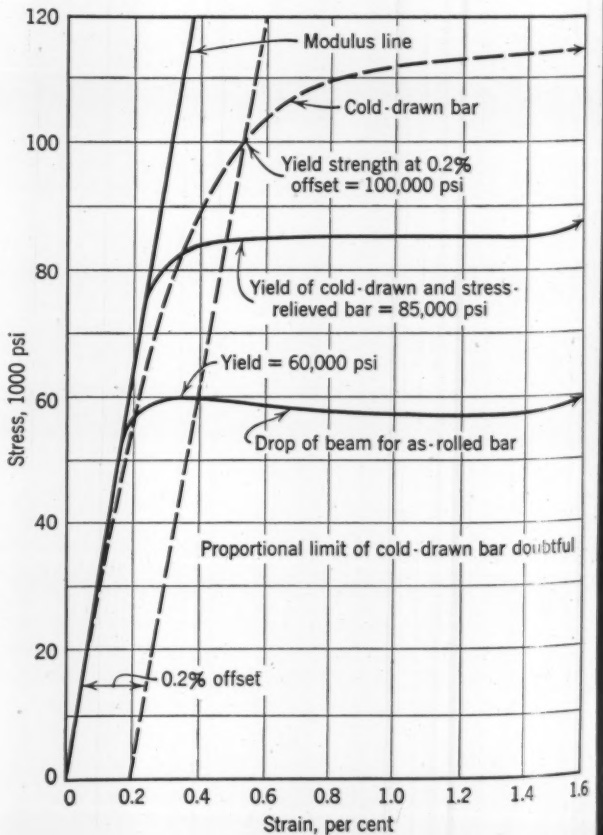


Fig. 3—Right—Effect of cold work on the stress-strain diagram. (From Frye[2])

chosen; a high proportional limit is sought.

Stress-strain diagrams give the elastic modulus, as in *Fig.* 2. The modulus is not materially altered when the microstructure and other properties are changed; it is practically fixed by the major chemical composition of the alloy but not affected by minor variations in composition. Like density, the modulus is not very sensitive to structure, but it can be somewhat altered by cold work, sometimes by precipitation hardening. For room-temperature service, hand-book values for modulus often suffice, without necessity for specific testing.

The modulus increases as temperature decreases and falls off as temperature increases, the change being rather linear until some high temperature, when it starts to drop abruptly. The rate of change varies with the alloy; hence, for very high or very low-temperature design, specific tests may be required.

Cast iron has a curved stress-strain diagram almost from the start. For rough calculation, its modulus is taken as a straight line from the origin to a stress equal to a quarter of its ultimate stress. Curves differ for strong and weak irons. The effective modulus may be as low as 10 million or as high as 25 million.

In many alloys the stress-strain diagrams for tension and for compression are closely alike up to yield strength, and this equality of yield strength is desirable in aircraft or other design where buckling is to be avoided. Such design often involves thin sheet, and obtaining accurate compressive stress-strain diagrams on thin sheet requires special technique. Quite fine-haired differences are of moment. Major differences occur in cast iron and in some magnesium alloys.

Cold work may or may not appreciably affect the modulus of a metal, but it does affect the diagram, as shown in *Fig.* 3 from Frye.[2] The curvature is believed to be due to internal stress, and, as *Fig.* 3 shows, a "stress-relief" anneal eliminates the curvature at low loads. Fully quenched, untempered steel, with much internal stress, shows excessive curvature.

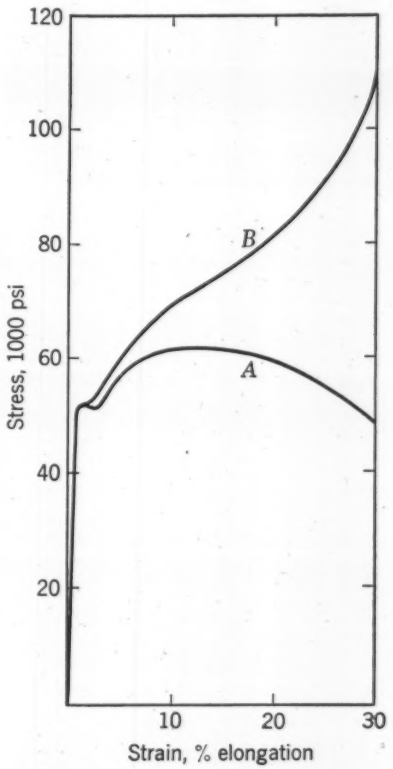


Fig. 4—Conventional stress-strain diagram, (A) based on original area, of a soft steel with a true yield point, giving 60,000 psi tensile, 50,000 yield, 30 per cent elongation.[4] True stress-strain diagram, (B), based on the actual area as it decreases during the tensile test

Complete Diagram Needed in Aircraft Design

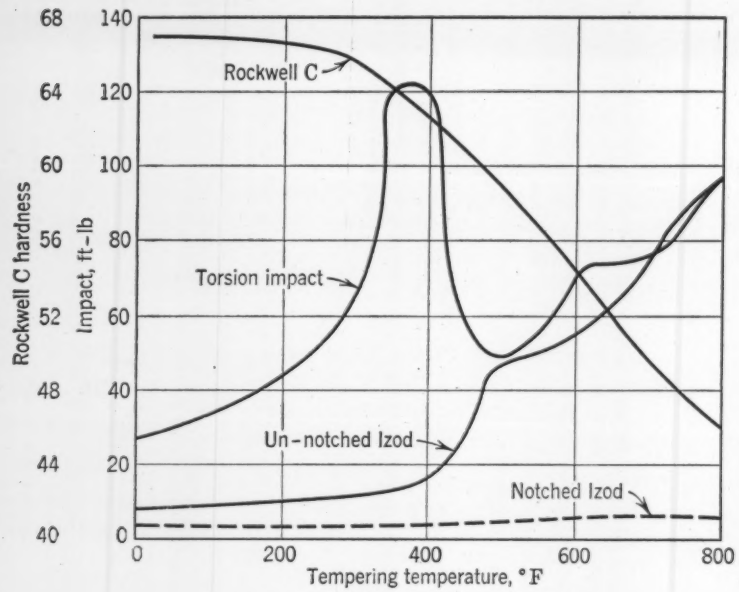
In aircraft design it is frequently possible to exceed the proportional limit and even the yield strength and allow a bit of permanent deformation, in which case the tangent or the secant modulus, determined up to some particular amount of permanent set, may be used, though for precise work the complete stress-strain diagram is needed. For other reasons as well, Wheelon[3] states that, to the aircraft designer, "the old criteria of ultimate tensile strength, yield strength, and elongation in 2 in., are not of much value. We need a full-range stress-strain diagram." The yield strength and modulus values so far discussed are directly applicable to design for static tensile loading and for design for stiffness.

Plastic Action: Now we come to other features of the diagram that are not directly applicable to design. These occur in the plastic range, from the yield strength up to fracture. In this range the ductile metals first stretch and finally neck down. During stretching the cross section decreases more or less uniformly over the whole length of the specimen. During necking, it decreases at one point. The per cent elongation, measured after fracture, includes both types of deformation. The per cent reduction of area is also measured after fracture. If the metal work-hardens readily, the elongation is spread over the length and the local necking is minor. Although the final reduction of area may be large, much of it is due to stretching, rather than to necking. If it does not work-harden readily, the piece necks sharply.

True Stress-Strain Diagrams: Because the cross section is diminishing during the test, the load in pounds per square inch plotted in the conventional diagram does not tell the actual load in pounds per square inch; it is higher than that plotted. If special methods are used to determine the actual cross section at each moment in the test, a corrected or *true stress-strain diagram* may be plotted,[4] as in *Fig.* 4. The course of the true diagram reflects the work-hardening behavior and is helpful in the plastic forming of metals.[5]

The ultimate tensile strength determined from the conventional diagram is a fictitious figure, since it is calculated from the maximum load divided by the original area, not the reduced area that actually exists at that load.

Yield Ratio: The ratio between the yield strength and the "fictitious" ultimate strength is the yield ratio. This varies in different alloys and in different



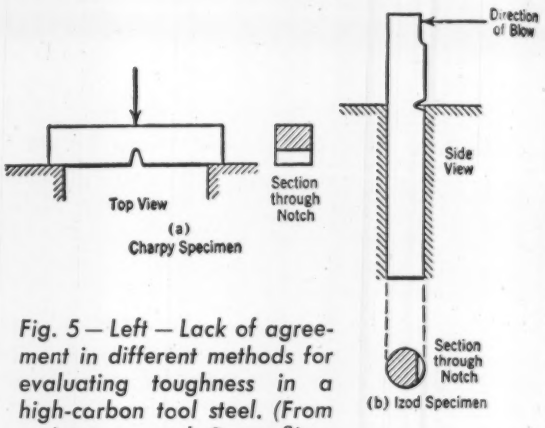


Fig. 5 — Left — Lack of agreement in different methods for evaluating toughness in a high-carbon tool steel. (From Luerssen and Greene[6])

Fig. 6—Above—Methods of loading single-blow notched-impact specimens. (Bullens, Battelle)

types of steels. Within a given group and with a given heat treatment, the ratio is quite constant. In earlier days, design using ordinary structural steel was based on tensile strength with a *factor of safety*. However, when other steels, such as the low-alloy, high-yield-strength group, or quenched and tempered steels are used, or when a nonferrous alloy is used instead of steel or another nonferrous alloy, tensile strength is an inadequate criterion and is now uniformly replaced by yield strength in design for static loading.

The area under the tensile stress-strain diagram is a measure of the energy absorbed up to fracture in tensile loading and hence has been used as a measure of *toughness*.

Usable Deformation: Since most designs will allow only slight plastic deformation before the structure becomes useless, total elongation is not an adequate measure, since it brings in unusable deformation. On this basis, use of high-strength, less ductile materials is justified for resisting static stress, but that idea has to be modified when repeated stress is involved and stress raisers are present. Although ductility often goes along with resistance to repeated stress, it is no measure of it, as is pointed out hereinafter. In fact, although ductility goes along with many desirable behaviors such as ability to be cold formed, it is again no direct measure of those behaviors, though it is often assumed to be.

Complete stress-strain diagrams and ductility figures—elongation and reduction of area—serve to indicate likeness or otherwise in tension of one lot to that of another that has the desired behaviors, but they do not insure that this likeness in tension connotes likeness in the other behaviors. To determine what variation in the ductility figures is meaningful, or merely accidental and normal, requires an intimate acquaintance with the particular alloy. Thus, elongation and reduction-of-area figures have no direct meaning to the designer and have to be supplemented by more direct tests for other behaviors.[3]

Combined Stress: Tensile strength, yield strength, and ductility figures give an inkling of resistance to and behavior under stresses applied in other directions but only an inkling. Pure tensile stress is rare. When stresses come in two or more directions, behavior under these biaxial or triaxial stresses cannot always be predicted from a knowledge of behavior under simple tension.

Directional Properties: Cast metals have closely similar properties in different directions, but wrought metals seldom have. Rolled metals frequently show somewhat different tensile and yield strengths when the test specimen is taken longitudinally (in the direction of rolling) or transversely (at right angles to the rolling direction). Ductility is likely to be markedly lower in the transverse direction, and the properties in the "through-plate" direction tend to be spectacularly poorer. Hence combined stresses with components other than pure tension are working upon material whose properties are not evaluated by the coventional tensile test. Application of the stresses to be met in service, both in magnitude and in pattern, to the particular material to be used, in full size and in its exact geometery, is often required for certainty of behavior.

Limitations of Tensile Data: That satisfactory service often depends on attributes not measured by the tensile test is evidenced in certain aluminum alloys, strong in tension, and hence favored for static service, but not better, or even worse, in resistance to repeated stress than weaker alloys. Two alloys might display identical tensile-test values and yet be widely different in other behaviors. On the other hand, within a particular group such as fully quenched and tempered steels, provided the carbon contents are similar, like tensile values frequently connote interchangeability, and this is true also for the mild-alloy steels. There is justification for accepting tensile values as a primary evaluation of potentialities but, invariably, other information is needed for adequate appraisal.

Sampling: Handbook values are usually given only

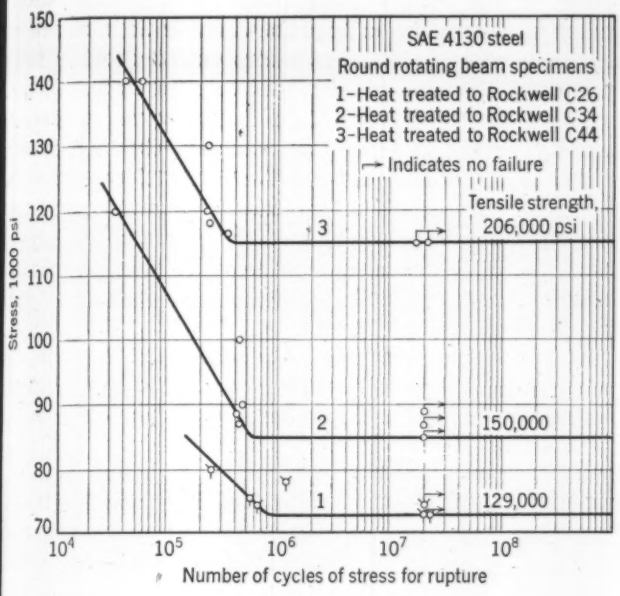


Fig. 7—Above—S-N curves for 4130 steel quenched and tempered to three strength levels. (From Fuller and Oberg[7])

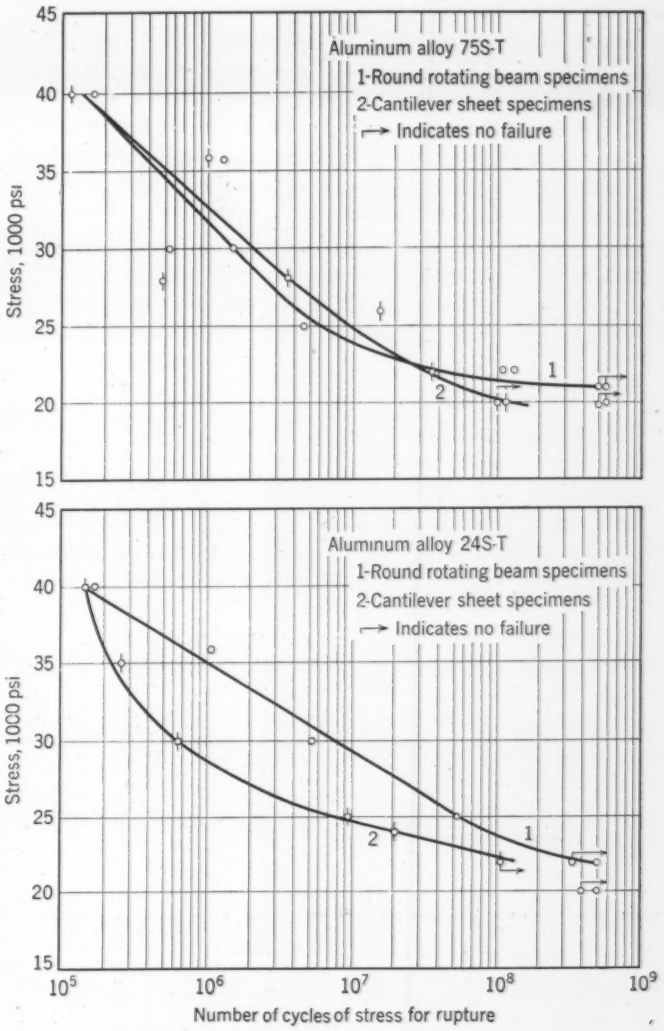


Fig. 8—Right—S-N curves for aluminum alloys. Alloy 75ST was treated to 87,500 psi tensile, 77,500 psi yield and 14 per cent elongation; alloy 24ST was treated to 84,500 psi tensile, 65,500 psi yield and 19 per cent elongation. The higher yield strength 75ST shows no superiority over the 24ST in repeated stress. (From Fuller and Oberg[7])

for longitudinal specimens of wrought metal, for small fully quenched specimens of heat-treated steel, and for fully fed specimens of cast metal; hence it needs to be noted whether or not a handbook or reported test value is on a true sample, one really representing the material as it is to be used. A value determined for an as-rolled or a normalized steel in one thickness will not necessarily hold for the same steel in another thickness, nor is the strength in one direction necessarily the same as in another. In a slack-quenched steel, a value determined on a fully quenched, smaller section will not hold for the slack-quenched interior of a larger section.

In castings, if the test is made on a separately cast (or even an attached) specimen, it may evaluate the quality of that heat of metal, but it does not evaluate that of the casting it is supposed to represent, for they freeze at different rates, and the test specimen is designed for adequate feeding, whereas the casting may not be.

HARDNESS TEST: The hardness test measures the indentation produced by some particular indenter under some particular load, according to some scale adopted for the test. With knowledge of the type of alloy being tested, the hardness values connote something as to strength, perhaps, as to wear resistance and machinability, but alone they mean nothing.

The systems most used are the Brinell or Rockwell B tests, in which a hard ball is pressed into a softer material and, for hard materials, the Rockwell C, Vickers (DPH), or Knoop tests, in which the indenter is a diamond point of conical, pyramidal, or rhombic shape, respectively. Higher hardnesses are denoted by higher figures. A steel of 400 Brinell has about 200,000 psi tensile strength. A steel of 400 Brinell is about 42 Rockwell C, 400 Vickers or Knoop. One of 60 Rockwell C is about 740 Vickers or Knoop. The curves for conversion of hardness values from one system to another, or from hardness to strength, are not linear.

BEND AND TRANSVERSE TESTS: A rough test for formability is the bend test in which a specimen of specified width is bent around a mandrel of diameter varying with the thickness of the specimen or, for thin sheet, sometimes bent flat upon itself and examined for cracking. This is a go, no-go test, not expressible in pounds per square inch and hence not a design value. The tensile ductility often fails to correlate with the ability to withstand bending.

Wheelon[3] shows a striking photograph of bend

tests on two ends of the same piece of aluminum alloy 75S in soft condition ⅛ in. thick. In ⅛ in. width, it bends 130 degrees without cracking. The 1 in. wide end bends only 79 degrees. The change in geometry introduces more constraint and more biaxial stress.

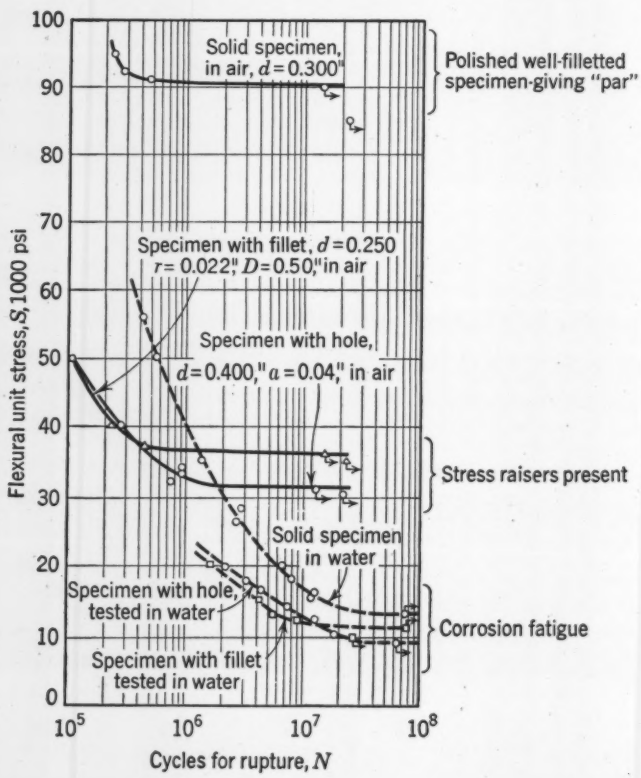
For relatively brittle alloys, such as cast iron, a transverse test is made. A specimen is supported near its ends and pressure is applied in the middle; the deflection (combined elastic and plastic) occurring up to facture and the load required to fracture are noted. The transverse strength, as it is usually measured, is not necessarily proportional to the tensile strength, and the deflection gives some inkling as to "toughness," but neither are design values. They are used for foundry control.

TOUGHNESS AND BRITTLENESS: Toughness is a vague property, related to the energy absorbed in producing fracture, which involves some combination of strength and deformability. Lead is deformable but not tough since it is so weak; cast iron may be very strong but has little toughness since it is but slightly deformable; yet it is not "glass-brittle." If a piece will stand battering without breaking, or if it merely splits slowly when it does break, it is tough, whereas if it readily flies into many pieces, it is brittle. One *piece* may be brittle, owing to geometry while the *metal* from which it is made will be tough in another piece of a different geometry. The same piece in the same geometry may be tough at one temperature, brittle at a lower temperature, as is explained later. The area under the stress-strain diagram in the room-temperature tensile test is often taken as a measure of toughness but is no measure of behavior of any other geometry or at another temperature. Various conventional test methods, alleged to measure toughness, often fail to give consistent results, as *Fig.* 5 from Luerssen and Greene[6] shows.

Conventional Notched-Bar Tests: Brittleness is more prone to show up in the presence of a notch, and the conventional "toughness" test has been the Charpy or Izod, in which the specimens are dissimilar in sharpness of the notch and in the dimensions back of the notch. Both specimens are very small and exert much less geometric restraint upon deformation than do most actual objects. The methods of loading differ, as shown in *Fig.* 6. These tests are reported in foot-pounds, not in foot-pounds per square inch, and cannot be extrapolated to other sizes or other notches. They are, therefore, far from design values. When ordinary ferritic steels are subjected to the Charpy or Izod or other notched test over a range of temperatures, at some low temperature the energy absorbed decreases more or less rapidly, and the fracture changes from the tough, tearing type to the brittle, shattering type.

Transition Temperatures: The temperature at which this change from ductile to brittle fracture starts to occur is called the transition temperature, but it is not a characteristic of the steel alone; it is a resultant of both the steel's innate properties and the geometry of the specimen. Different sizes of specimen or different notches give different transition temperatures. Such tests on specimens smaller than the objects they are supposed to represent uniformly indicate lower transition temperatures than hold for larger sections. Hence there is a growing tendency to discard the conventional notched-bar test, even when it is carried out over a range of temperature; to use full-sized objects, with the stress raisers they actually carry; and to test at below the actual temperature range of service.

Fig. 9—S-N curves comparing fatigue behavior with and without stress raisers and corrosion (From Dolan[8])



Type of Fracture More Significant

The type of fracture tells as much as or more than the figure for foot-pounds absorbed. Neither the energy absorbed nor the "transition temperature" in the conventional tests are of any quantitative value.

REPEATED STRESS: Although yield strength is a sound criterion for static loading, it is no criterion for resistance to repeated stress under which fracture may occur well below the yield strength and without any measurable plastic deformation. The endurance is evaluated by running a series of well-filleted, highly polished specimens, as free as possible from surface stress raisers, at various loads. The stress is plotted against the number of cycles endured to fracture, usually with logarithmic or semilogarithmic plotting, giving curves like *Figs.* 7 and 8 from Fuller and Oberg.[7]

Steels show a true endurance limit as in *Fig.* 7; most other alloys do not. The values for the others are reported in stress for a selected life, say 50 million or 500 million cycles. The values are in pounds per

(*Continued on Page* 198)

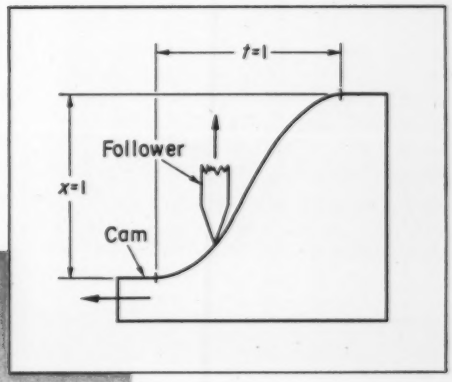


Fig. 1 — Simplified nondimensional arrangement used for comparison of profiles

Cam Dynamics

Is there a definitive criterion for profile design?

By Alfred S. Gutman

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COMPLEXITIES in the dynamic aspects of cam and follower systems invite the investigation of any rational approaches that might lead to more effective design procedures. This article presents a comparison of several cam profiles from a point of view that is gradually receiving more attention. Rate of change of acceleration, which for want of a better name might be termed "jerk," is beginning to be viewed as a more useful index of dynamic characteristics than acceleration alone.

To think only of rate of change of acceleration is, of course, to oversimplify the problem. However, the study here outlined shows how the concept of jerk might be advantageously explored. It remains for the designer to combine criteria so developed with other limiting influences such as pressure angle, mass, stiffness, etc.

For simplicity, this discussion is presented in nondimensional terms, that is, for cams that are intended to cause unit displacement in unit period of time. The time scale is equivalent to a cam moving in a straightline path and displacing a follower in the perpendicular direction, as shown in *Fig.* 1.

Further, it is assumed that the following boundary conditions are required:

When time $t=0$, displacement $x=0$, velocity $dx/dt=0$.
When time $t=1$, displacement $x=1$, velocity $dx/dt=0$.

Smooth operation of the mechanism with minimum wear is desired in the curve selected for connecting the two points, $t = 0$, $x = 0$ and $t = 1$, $x = 1$.

Equations for displacement, x, are given here for two families: polynomial and trigonometric. The polynomial orders are simply second, third, fourth, and fifth-power equations. The second-power equation is, of course, the traditional parabolic or constant-acceleration curve. The trigonometric orders are also well-known forms, the simple harmonic and the cycloidal. Equations for these families are given in TABLE 1 and TABLE 2; their corresponding curves appear in *Fig.* 2.

It should be observed that the equated functions apply only between the boundaries of each profile region. For certain profiles, such as the second-power, they fail to define the range of values at the boundaries. Graphs of *Fig.* 2 complement the equations in showing discontinuities not directly apparent from the stated mathematical functions.

POLYNOMIAL EQUATIONS: An infinite number and variety of powers can be employed to specify displacement characteristics. Some useful results have been obtained with combinations of rather high powers,[1] but this comparison is confined for convenience to the lower orders.

Second Power: If all parts were perfectly rigid and if there were zero backlash, the two-region parabolic profile would give a better result than any other type. Its acceleration is only 4 units. But change of acceleration equals infinity. With any backlash, this infinite jerk leads to rapid destruction of the cam.[2] If parts of the mechanism are elastic, rapid changes in acceleration produce vibration.[3] Either factor is sufficient reason to design for finite jerk as well as minimum acceleration.

Third Power: The cubic form comprises three re-

[1] References are tabulated at end of article.

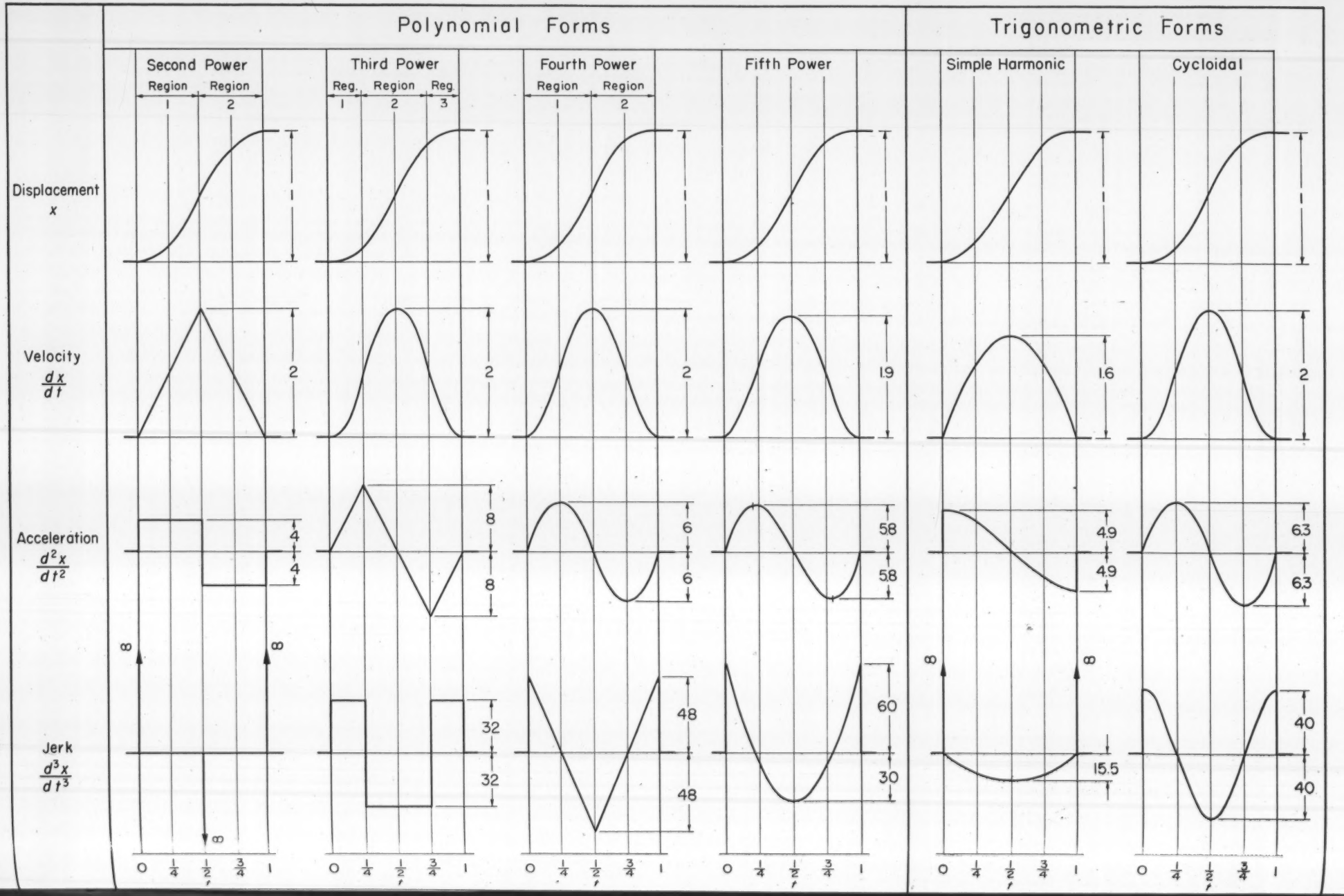
Polynomial Forms
Trigonometric Forms
Second Power
Region 1
Region 2
Third Power
Reg. 1
Region 2
Reg. 3
Fourth Power
Region 1
Region 2
Fifth Power
Simple Harmonic
Cycloidal
Displacement
x
Velocity
dx/dt
Acceleration
d²x/dt²
Jerk
d³x/dt³
1
2
1.9
1.6
4
4
8
8
6
6
5.8
5.8
4.9
4.9
6.3
6.3
32
32
48
48
60
30
15.5
40
40
8
0
1/4
1/2
3/4
1
f

Table 1—Equations of Cam Characteristics for Polynomial Forms

Characteristic		Second Power		Third Power		
		Region 1 $t = 0$ to $\frac{1}{2}$	Region 2 $t = \frac{1}{2}$ to 1	Region 1 $t = 0$ to $\frac{1}{4}$	Region 2 $t = \frac{1}{4}$ to $\frac{3}{4}$	Region 3 $t = \frac{3}{4}$ to 1
Displacement	x	$2t^2$	$-2t^2 + 4t - 1$	$\frac{16}{3}t^3$	$-\frac{16}{3}t^3 + 8t^2 - 2t + \frac{1}{6}$	$\frac{16}{3}t^3 - 16t^2 + 16t - \frac{13}{3}$
Velocity	$\frac{dx}{dt}$	$4t$	$-4t + 4$	$16t^2$	$-16t^2 + 16t - 2$	$16t^2 - 32t + 16$
Acceleration	$\frac{d^2x}{dt^2}$	4	-4	$32t$	$-32t + 16$	$32t - 32$
Jerk	$\frac{d^3x}{dt^3}$	0	0	32	-32	32

Characteristic		Fourth Power		Fifth Power
		Region 1 $t = 0$ to $\frac{1}{2}$	Region 2 $t = \frac{1}{2}$ to 1	Region $t = 0$ to 1
Displacement	x	$-8t^4 + 8t^3$	$8t^4 - 24t^3 + 24t^2 - 8t + 1$	$6t^5 - 15t^4 + 10t^3$
Velocity	$\frac{dx}{dt}$	$-32t^3 + 24t^2$	$32t^3 - 72t^2 + 48t - 8$	$30t^4 - 60t^3 + 30t^2$
Acceleration	$\frac{d^2x}{dt^2}$	$-96t^2 + 48t$	$96t^2 - 144t + 48$	$120t^3 - 180t^2 + 60t$
Jerk	$\frac{d^3x}{dt^3}$	$-192t + 48$	$192t - 144$	$360t^2 - 360t + 60$

Fig. 2—Left—Curves of displacement, velocity, acceleration and jerk for polynomial and trigonometric cam forms

Table 2—Equations of Cam Characteristics for Trigonometric Forms

Characteristic		Simple harmonic Region $t = 0$ to 1	Cycloidal Region $t = 0$ to 1
Displacement	x	$\frac{1}{2}(1 - \cos \pi t)$	$t - \frac{1}{2\pi} \sin 2\pi t$
Velocity	$\frac{dx}{dt}$	$\frac{\pi}{2} \sin \pi t$	$1 - \cos 2\pi t$
Acceleration	$\frac{d^2x}{dt^2}$	$\frac{\pi^2}{2} \cos \pi t$	$2\pi \sin 2\pi t$
Jerk	$\frac{d^3x}{dt^3}$	$-\frac{\pi^3}{2} \sin \pi t$	$4\pi^2 \cos 2\pi t$

gions: $t = 0$ to $\frac{1}{4}$, $t = \frac{1}{4}$ to $\frac{3}{4}$ and $t = \frac{3}{4}$ to 1. It offers the lowest jerk of any of the tabulated profiles, but its acceleration (8 units) is one of the greatest.

Fourth Power: This form is composed of two regions: $t = 0$ to $\frac{1}{2}$ and $t = \frac{1}{2}$ to 1. As with the third-power form, the displacement, velocity and acceleration curves join without interruption from one region to the next because the displacement equations and their first and second derivatives are planned to have identical values at their junction points. In this case, both acceleration and jerk are moderate.

Fifth Power: The fifth-power form comprises a single region but its acceleration curve is not symmetrical about $t = \frac{1}{4}$ and $\frac{3}{4}$. Maximum acceleration and deceleration are obtained by equating jerk (first derivative of acceleration) to zero and solving for t. Substituted in the acceleration equation, these values, $t = 0.21$ and 0.79, give 5.8 and -5.8. Maximum jerk and acceleration values do not differ in important degree from those found for the third and fourth-power forms.

It is of possible significance that an infinite *rate of change of jerk* occurs at two or more points for the third, fourth and fifth-power forms.

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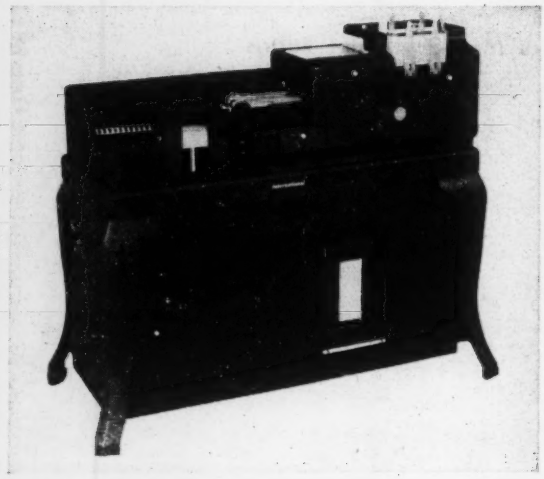
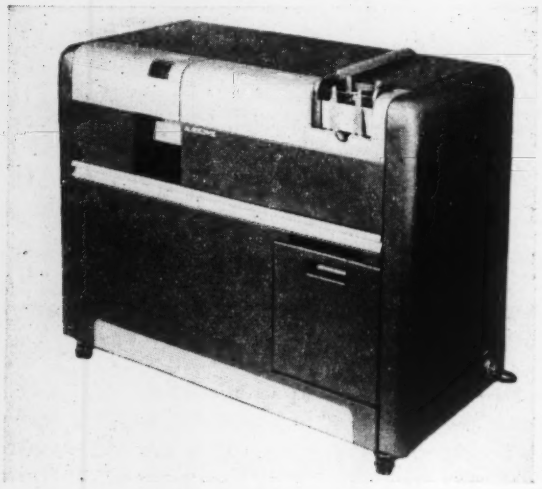
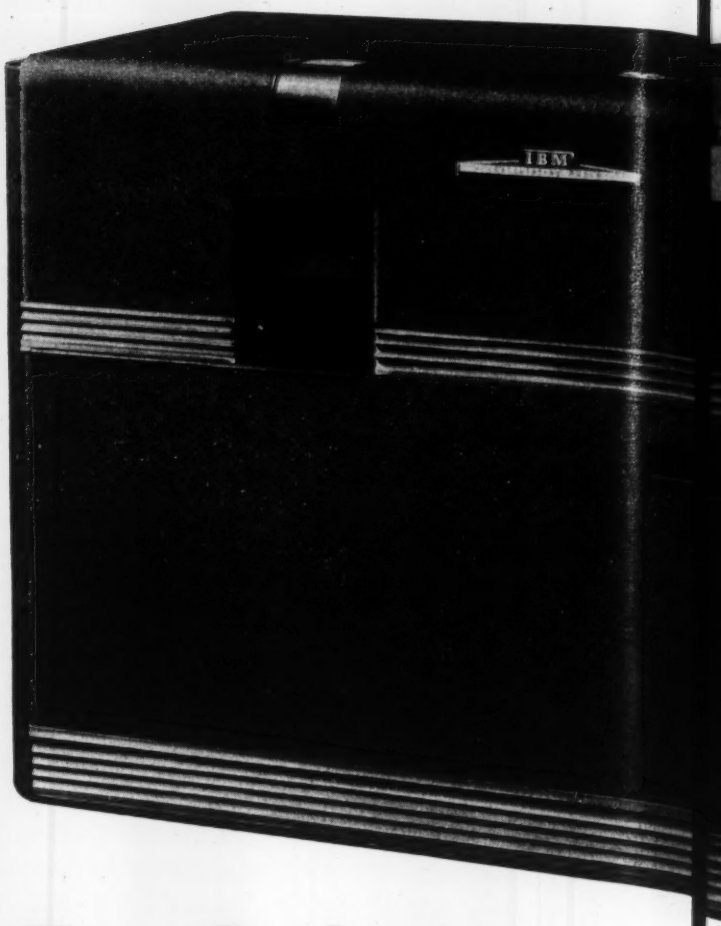


Fig. 1—Above—Original calculating punch being redesigned for appearance

Fig. 2—Below—First redesign of calculating machine is enclosed in sheet metal housing. Stamped end panels contributed to high tool costs, making second redesign necessary





How Redesign Improves Appearance

THREE basic requirements of designing for appearance are to develop a design that is economically justified, that may be fabricated by available production methods, and that has a pleasing and efficient appearance. While working closely with the engineering and production departments, an industrial designer is not assuming his whole responsibility unless he integrates these basic requirements into a new design that is a definite improvement over previous models.

From its appearance, a machine should be recognized for the function it performs. When a new model is designed, or an old one restyled, the designer should strive to achieve a character or atmosphere that is a definite part of that product alone. Industrial designers deplore the recent trend to make all mass-produced products look streamlined.

It is not necessary, for example, to have all surfaces crowned. In many cases, a straight line and a radius produce an effect more in harmony with surroundings than the soft forms resulting from all curved surfaces. Just as an architect places windows and doorways in a carefully planned relationship to each other and to the whole, so the designer must relate elements such as openings, access doors, and joint lines in such a way that the end product looks well organized and pleasing in its proportions. Factors such as ease of access, proper height of working surfaces for greatest efficiency and types of materials suitable both in appearance and durability must all be reconciled with the desired proportions and aesthetic effect.

The designer does not need to use expensive methods of fabrication and costly materials to gain the effect of pleasing proportions and clean lines. A harmoniously pleasing impression can be obtained by the use of bold, simple forms and concentration of detail at one focal point determined by the func-

Fig. 3—Second redesign of calculating machine. Simple radii and extruded aluminum moldings involve lower tool costs and more economical construction

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Reduces Cost

tion of the product. Texture and color often enhance appearance. Textures created by ventilation grilles and working surfaces are not only functional but also serve to enrich the design by creating a contrast. Likewise, the use of two colors can correct an otherwise bad proportion.

Styling with emphasis placed on tooling cost is of prime importance to the manufacturer when volume of production is low. In cases where the tooling budget is unlimited, no particular ingenuity is required in order to develop a good design. But, there still are many types of products which do not give the industrial designer a free hand to find the "ideal solution." Here, he must be in sympathy with the problems of engineering and sales, and must become part of the team in achieving a design which is successful economically as well as aesthetically.

It is equally as important for the designer to be familiar with the types of equipment and processing in the plant as it is to know the merchandising methods of the sales department. It is true, of course, that manufacturing methods sometimes can be improved after a product has been newly designed. But, instead of this "cart-before-the-horse" principle, suggested changes in fabrication should be evaluated in the early stages of design. Only in this way, can the more obvious wild goose chases be prevented.

Thus, it is of major importance for the designer to help keep tooling cost down, as long as he does not sacrifice appearance in doing so. In each of the following case histories, tooling cost was an important factor. And in each case, the co-operation and guidance of both engineering and production departments achieved a successfully designed product.

The first case history is that of styling a new calculating punch, a product of International Business Machines Corp., *Fig.* 1. Fundamental to the new design of this machine was the inclusion of a shock-mounted mechanism floated on an angle-iron frame. The height of this mechanism came to approximately the vertical center of the machine, necessitating a housing design which would be sufficiently rigid to support itself and any weight that might be placed upon it.

The design objective was a machine with a clean and efficient outside appearance which would sug-

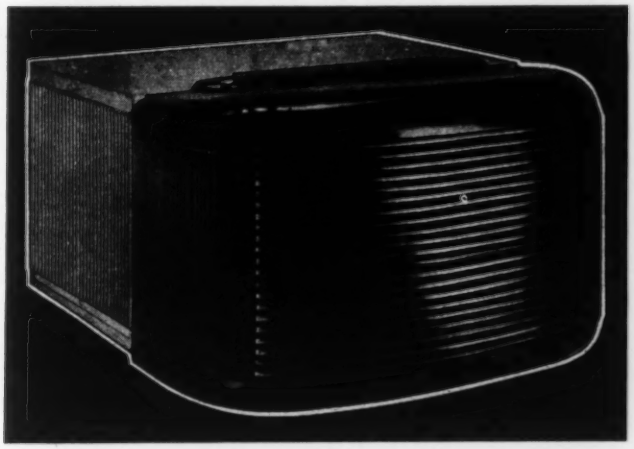
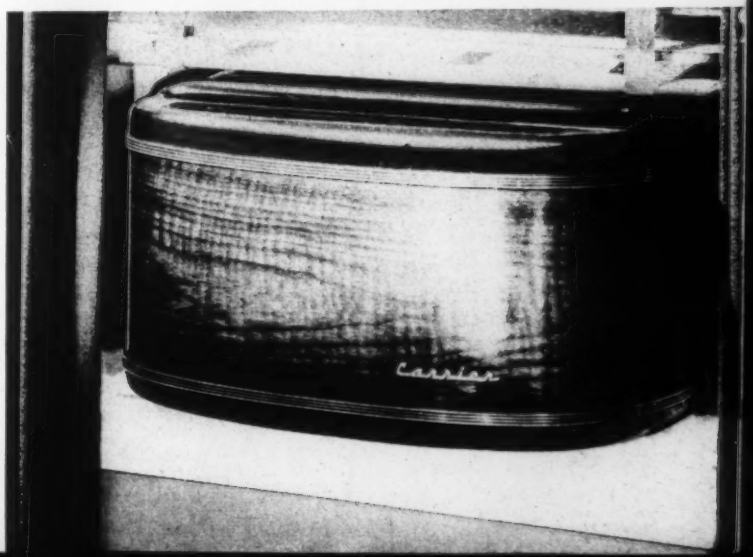


Fig. 4—Above—Original design of window air conditioner showing molded plastic front grille. Air intakes are at the sides and air output is at front

Fig. 5—Below—Redesign of air conditioner has louvers at the top for both intake and output. The body is a simple wrapper type construction with wood grain effect



gest a feeling of businesslike efficiency and confidence on the part of the operator. To achieve this objective, IBM wanted to enclose as much of the mechanism as possible under steel covers. Thus, many mechanical parts of the machine such as complicated castings and electronic devices which might inhibit the average clerical operator would be hidden from view. Further, it was desired to avoid tempting the amateur mechanic who might otherwise tinker with the machine.

These covers were to be constructed in such a manner that they could be mounted to the frame in which the rest of the machine was shock-mounted. The covers were carefully studied so that the dividing lines would fall in some sort of harmonious relationship and they were given a shape which provided maximum strength and freedom from warpage. All sandcastings were to be concealed within the sheet metal covers, rather than being exposed as in the past. This was because these castings presented an appearance problem due to their shapes and to their rough surfaces.

All Covers Are Latched

Another design problem resulted from the fact that various areas inside the machine had to be easily reached by the operator. This necessitated a design incorporating hinged covers in certain parts of the machine. Because of the complex operations performed by IBM machines, it is necessary that a service engineer check the machine periodically, without having to spend too much time removing and replacing the covers. Therefore, it was decided that a special, positive latching device be used, instead of the great number of screws used previously. In doing this, a functionally correct cover was achieved eliminating pock-marks which gave the covers a disturbing appearance.

A design was developed which used large stampings for both side covers, and a wrap-around cover for the back, top and front. This design resulted in a smooth appearance even though the machine was made up of a number of covers. This machine, *Fig.* 2, was satisfactory from the standpoint of appearance. However, it was to serve as a prototype for the styling of a whole line of IBM machines to perform different functions. To tool up for special stampings for a limited run for each of these models proved to be prohibitive costwise. Furthermore, production experience with the first design disclosed that because of accumulated tolerances the stamped covers fit together poorly.

Simple Radii Reduce Costs

As a result, the machine was re-engineered after a short time. This presented the opportunity of reviewing the industrial design problems. A very successful design, using radii extending only in one direction, was then achieved, *Fig.* 3. A radius of about 1½ inches was selected as being in the proper scale or relationship with the size of the machine. Thus sharp corners are avoided and, at the same time, a clean, crisp tailored appearance is created in keeping with the atmosphere of modern office interiors.

All radii and curves are limited to to those that can be made with inexpensive brake machinery. One of the important improvements is the overlapping of the side covers by the front, back and top covers. This allows latitude of slip-joint adjustment to take up all dimensional variations. This overlapping fea-

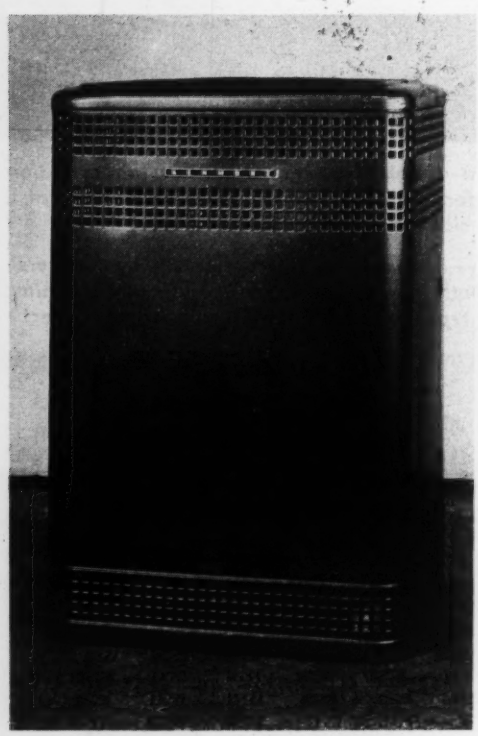


Fig. 6—Left — Original design of heater has a wrapper type cabinet with perforated openings. Door is on the side and front panel is plain

Fig. 7 — Right — Redesign of space heater. While still a wrapper type cabinet, it has a heat-deflector door on top tied in with a decorative front panel. Lighting door is also on the front

Fig. 8—Far Right—Portable air compressor redesigned to integrate the components. Handle is part of die-cast aluminum head, offset to balance greater weight of motor

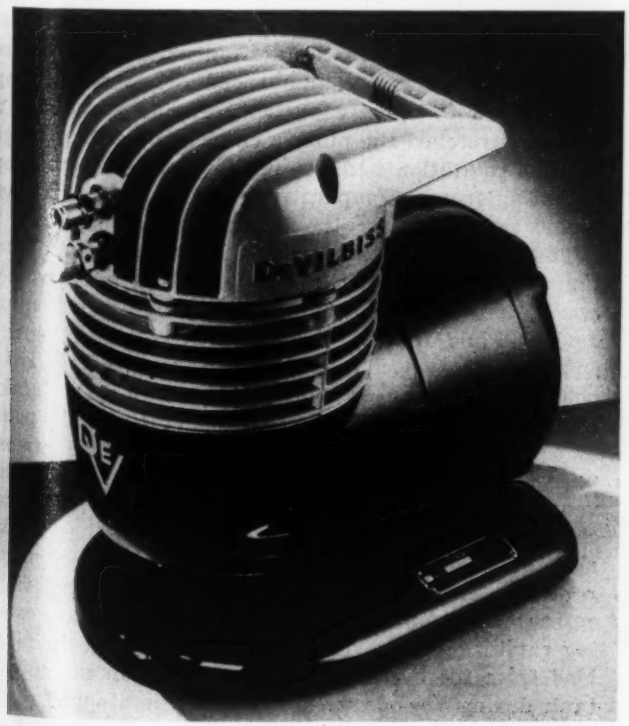
ture has been developed into a design theme which carries through to all the other accounting machines in the IBM line, thus giving a closely related family appearance.

To absorb tolerances, adjustments were necessary in the vertical plane of the machine. This was done by the use of aluminum extrusions which are not only decorative but low in tool cost. These extrusions are placed at the belt line of the machine, thus providing a mounting place for hinges in addition to serving as a concealed adjustment point and decorative strip.

Finally, on the original machine, the controls and signal lights had been placed at various locations. In the new design, these controls are grouped in one location, both for ease of operator control and for better appearance. This design is a happy solution to the problem of function, cost of parts, cost of tooling, appearance, and operator control. To make the design quiet in appearance as well as in function, brushed aluminum is employed only in places subject to constant abrasion. The simple fabrication methods employed result in a machine that harmonizes with other office furniture such as desks and file cabinets that are subject to the same manufacturing limitations.

The second case history is that of designing a window air conditioner for Carrier Corp., *Figs.* 4 and 5. This is an example of a stem-to-stern face lifting job, in which a completely new appearance as well as functional design changes, are achieved at a minimum cost for new dies and fixtures. A curved shape plan of design is employed, primarily because this eliminates the problem of obtrusive bulk protruding into the room.

The old model had involved expensive tooling. It was management's desire to develop some new features and a more efficient method of distributing the air. But they didn't want a complete redesign of the housing which would mean, in turn, redesign of the interior frame, stampings and miscellaneous parts.



Louvers Are Confined to Top of Unit

It was decided to retain the existing bottom stamping which formed the base of the whole mechanism. As the intake and outlet grilles were moved from the sides and front to the top, the expensive shell of the machine, with its plastic front grille, was eliminated in favor of an inexpensive wrapper construction. In addition, the shell is designed to blend with office and home surroundings by giving it a wood grain effect. The top stamping die was reworked to provide for the two louver systems, intake and cooling. This was accomplished economically, since it was found that some of the dies could be used in the new design. Extruded aluminum trim is used to conceal the joints between top and bottom stampings and the wrapper construction. Controls are located at the ends of the intake louvers. A small unobtrusive nameplate serves to identify the product.

The third case history is that of the new Kenmore space heater manufactured by the Prentiss Wabers Products Co. for Sears, Roebuck and Co. The primary purpose of redesign was to produce a more attractive piece of merchandise so that sales and hence production increases would result.

Practically every heater in the industry had the same general appearance, *Fig.* 6. As something new, the company's engineering department suggested an adjustable blower door. This suggestion was incorporated in the redesign as a merchandising feature and the theme of the whole design, *Fig.* 7. When open, the blower door exposes a businesslike appearing grille through which heated air is delivered. And by designing a vertical front panel, in line with the blower door, a distinguishing theme was developed, making Kenmore line easily recognizable. In addition, the top is sloped back slightly to heighten the directional effect of the air.

Utilizes Stamping Facilities

The plant in which this heater is made, has extensive experience in a wrap-around type of sheet metal construction. In fact, the whole layout of the factory is premised on this method and space is at a premium. There is little room between stamping machines or near the assembly lines for stacking large stampings.

In solving this problem, it was desirable to design the main body of the heater housing in a flat form, with all holes and embossings prestamped. Thus, it travels through the plant in this form, until, at the last operation, it is put into a bending fixture, bent into a four-sided housing, and welded together. This results in considerable saving of valuable factory storage space, as well as in handling. The stamped top, containing the heating grille, fits snugly over the

wrap-around housing, thus stiffening and aligning the whole structure.

It was decided that three sizes of housings were necessary in order to properly merchandise the line of heaters. This would ordinarily require three sets of dies. By making identical front panels and blower doors, it is possible to vary merely the size of the wrapper cabinet to fit the three different size top panels. A feature of the hinged blower door is that it either directs the heat to the floor, or by raising the adjustment of the door, directs the heat across the room. A heat resistant bakelite handle provides a heat-proof grip. This handle also doubles as a nameplate, with the name embossed on a thin bronze insert.

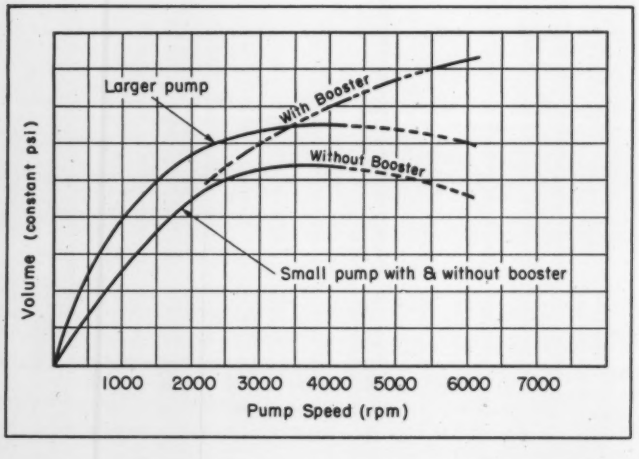
One of the principal problems confronted in designing this heater concerned finishing. Tests showed that most lacquers could not withstand the high temperatures involved. In order to conceal imperfections in the steel and also to avoid costly metal finishing, a spatter finish is employed, giving a rough texture to the metal. Finally, a synthetic with a high aluminum powder content was found to give excellent results, withstanding the high temperatures.

The fourth case study is the DeVilbiss air compressor. It was desired to add sales appeal to a carefully engineered compressor by giving it a coherent, designed-for-the-purpose look. Emphasis was also put on portability and a neat efficient appearance. The design problem was to integrate the air intake, the handle, the compressor cylinder and the motor into a smoothly contoured unit. One of the important functions of the cylinder head is to dissipate excess heat. In the re-design, *Fig.* 8, six deep fins are provided at the top to help carry heat from the chamber. The handle is planned in the best relation to the center of gravity and is part of the die-cast aluminum head. It is extended to a point above the motor where it is in line with the center of gravity. The motor, being much heavier than the compressor proper, would make a conventional central carrying handle appear off-balance. While the new design evolved high tooling costs for this type of machine, its lightweight, compact, efficient and functional appearance have so appealed to the consumer that increased sales have justified the investment.

Venturi Booster Increases Pump Efficiency

AN INTERESTING solution to the problem of pressure loss at high speeds in geared, rotary vane and centrifugal pumps in the form of an input booster without any moving parts has been announced by F. W. Davis, consulting engineer of Waltham, Mass. Most geared or vane type pumps have a critical speed, above which the theoretical output exceeds the ability of the intake to supply the necessary liquid. When this speed is exceeded, cavitation—formation of partial vacuums or pockets within the pump—occurs. This cavitation effect causes a drop in output pressure, surges in the flow, pump noise, and impeller or gear and bearing wear.

The new booster employs a simple venturi to automatically accelerate the input flow at high speeds, assuring a steady input of solid fluid to the impeller. It also eliminates efficiency loss due to entrained air. It greatly increases the range of speed at which pumps can operate at or near peak efficiency. A typical installation is a gear pump for a power steering mechanism for automobiles. To supply the required minimum pressure at engine idling speed (about 500 rpm) would require a large pump. But a large pump provides much more volume than necessary at low speeds and pressure can not be maintained due to cavitation at high engine speeds (about 3500 rpm) such as in low-gear operation of the car. Pump noise was very objectionable and pressure surges made the operation of the power steering mechanism erratic. To obtain the desired minimum pressure and volume at low engine speeds, a smaller pump was geared to operate at twice engine speed and a booster stretched the pump's efficient operating range so that cavitation had not begun at the engine's top operating speed. Comparative performance of the two pumps is shown by the accompanying curves.



The booster contains no moving parts. Its operation is dependent upon the difference in pressure between the static head and velocity head in a venturi device. Fluid flowing through the restricting nozzle furnishes the velocity head, which would normally be below atmospheric pressure when entering the intake side of the pump. Connection is made at this point to a supply and make-up tank vented to the atmosphere. Consequently, the fluid in the throat of the venturi is raised to atmospheric pressure, thereby creating a boost or super-charge at the intake side of the pump. By assuring that atmospheric pressure is substantially maintained as the fluid enters the pump, the partial vacuum condition causing cavitation is prevented. Air entrained in the oil is bled from the system through the vent in the supply tank during periods when the pump is stopped.

Selection of Gear Materials

Results of some studies of gear tooth surface stresses under specified contact conditions based on investigations of Meehanite metal

By C. R. Austin
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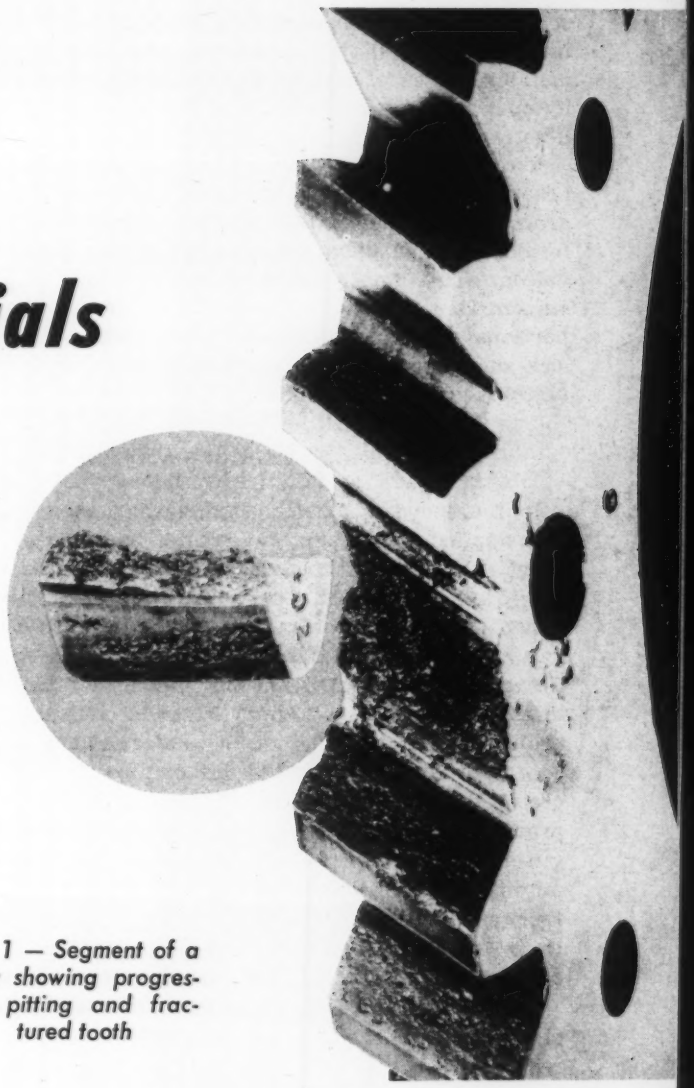


Fig. 1 — Segment of a gear showing progressive pitting and fractured tooth

WHEN a gear tooth fails, it usually does so by the development of unsatisfactory surface conditions and only infrequently by breakage. Repeated application of surface stresses may suffice to cause destruction of the surfaces by flaking or pitting or in conjunction with the relative sliding of the surfaces may subject the lubricant to

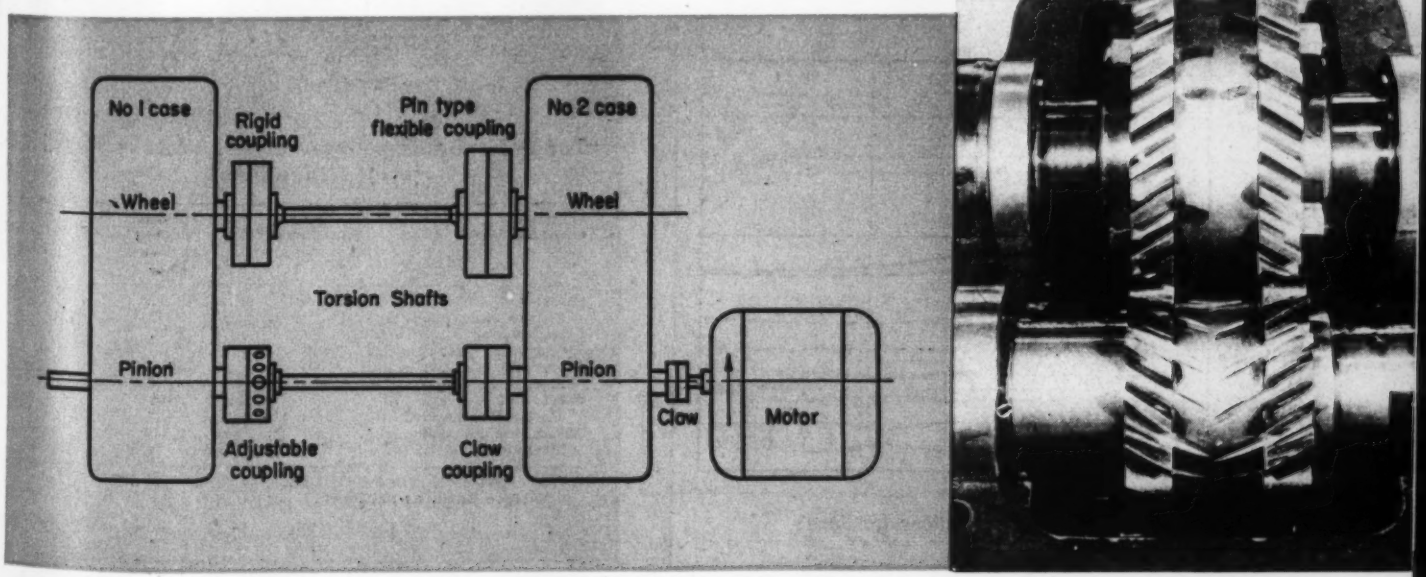


Fig. 2—Below—Diagrammatic layout of the helical gear power circulator and a pair of Meehanite test gears in place in the unit

conditions that it is unable to withstand. When the lubricant fails, sliding contact is established between metal surfaces of the teeth and failure often occurs by spot welding in the form of seizing or scuffing as illustrated in *Fig.* 1.

It is well known that the design proportion of practically all types of gears and gearing is standardized by the application of a number of different formulae based upon years of experience and observation. This development has resulted in a series of standard specifications being laid down for the proportions of gear wheel bosses, arms, rims, face widths, size and number of teeth, shape of teeth, load carrying capacity, etc.

Choice of Material Important

In recent years, continued increase in gear speeds and applied loads has necessitated closer and more exact studies of the behavior of materials under working conditions more nearly approaching those to which the gear teeth are actually subjected. Equally has it become recognized that the choice of material for gear manufacture depends upon the limitations imposed by manufacturing methods and the basic property characteristics of the materials selected. In the case of cast materials the engineer is also correctly concerned with both the uniformity of the product and the reproducibility of the necessary engineering properties to a given specification. This might also involve the practicability of increasing the resistance of the gear teeth to surface breakdown and wear by simple heat-treating procedure cr surface hardening.

The tensile strength per se is of relatively little significance to the design engineer who is concerned with the behavior of a metal under progressive load increments in terms of strain. However, fatigue properties are particularly important in gear per-

Fig. 3—Comparative notch sensitivity of Meehanite and steel in notched and unnotched bars

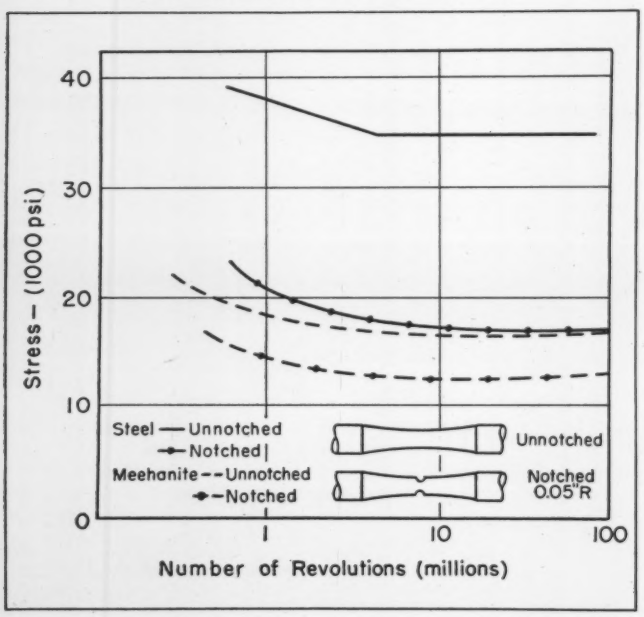


Table 1—Comparative Data for Gear Materials*

Type of Material	Tensile Strength (psi, min)	Brinell Hardness Number (min)	Surface Stress Factor†	Bending Stress Factor
Meehanite GM (Heat treated)	55,000	425	2400	17,000
Meehanite GM (as cast)	59,400	230	1600	18,000
Meehanite GA	50,600	210	1450	15,000
Meehanite GC	40,700	190	1400	14,000
Malleable castings	44,000	140	850	11,000
Cast Iron	26,400	165	1000	5,300
Cast Iron	35,200	210	1350	7,500
Cast Iron (alloyed)	48,400	220	1450	10,400
Phosphor bronze (sand cast)	26,400	69	700	7,000
Phosphor bronze (centrifugally cast)	37,400	90	1000	10,000
Cast steel (carbon 0.35/0.45 per cent)	77,000	125	1400	19,000

* Data from tests conducted by David Brown & Sons Ltd., England. Studies are based on methods outlined in British Standard Specification BSS 436-1940, and data is given for purpose of materials comparison only.

† Surface stress factor is derived from the surface stress at failure by dividing with an arbitrary factor of 4. Permissible bending stress factor is obtained by dividing the bending stress at failure by 4.

Table 2—Stanton Repeated-Blow Impacts

Metal	GM	GA	GB	GC	GD	GE
No. of blows to fracture (approx.)	14,000	12,000	8000	3000	500	100

Table 3 — Surface Roughness Geometry of As-Machined Surface

Material	Parallel to Tool Marks (microinch, rms)	Across Tool Marks (microinch, rms)
GA Meehanite, cast	20 to 65	80 to 110
Steel, SAE 1035	10 to 20	50 to 70
GE Meehanite, cast	40 to 160	120 to 240
Graphitic cast iron	80 to 360	100 to 220

Table 4—Effect of "Wear-In" on Surface Roughness Geometry

(Average finish, microinch, rms)

Mating Surface	Original Surface — Along Feed Marks	Original Surface — Across Feed Marks	Surface After "Wear-In" — Along Feed Marks	Surface After "Wear-In" — Across Feed Marks
Steel	15	60	0.9	7
GE Meehanite	40	80	35	60

Table 5—Galling Pressures For Various Metal Combinations

Metal Combination*	Surface Smoothness† (microinch, rms)	Initial Galling Pressure (psi)	Coefficient of Friction (Average)
Steel and Bronze	60	Under 2000	0.22
	40		
Steel and Graphitic Cast Iron	60	2750	0.16
	160		
Steel and Meehanite GE	60	3500	0.16
	125		
Steel and Meehanite GA	60	3000	0.16
	70		
Meehanite GA and Meehanite GA	65	2750	0.11
	75		

* All steels cold-rolled SAE 1035.
† Surface finish as-machined.

formance as they relate to:

1. Simple fatigue, under bending stresses, which is indicative of load carrying capacity of the teeth
2. Surface stress factor, which is an index of surface breakdown or disintegration by scuffing, spalling, pitting, or compression fatigue.

To predict the performance of a pair of gears it is therefore necessary to study the surface stresses set up by specified contact conditions and to investigate the ability of materials and of lubricants to withstand the stresses involved. The studies reported have reference primarily to the properties of certain types of Meehanite metal.

Tests Made on Helical Gears

TESTS: All tests were conducted on helical gears mounted in pairs, *Fig.* 2, on a machine known as the helical gear power circulator. The circulator, *Fig.* 2, consists of two identical reduction gear cases of standard design in which are mounted two sets of gears. In one case are located the gears to be tested, while the other contains gears of the same ratio and center distance but of higher load capacity than the test gears. A summary of a series of tests provides comparative data for gear materials as used for spur and helical gears, TABLE 1.

Shock Resistance: A property frequently important in gear performance is that giving an index of resistance to failure under repeated shock. In the Stanton impact test, a hammer is repeatedly dropped from a constant height onto the test sample until fracture occurs. Data obtained on the various types of Meehanite metal are provided in TABLE 2. Since the lowest strength GE Meehanite most nearly approximates an ordinary gray iron, the results clearly demonstrate that Meehanite types GM and GA possess exceptional shock resistance.

Notch Sensitivity: There are relatively few engineering applications where notches, grooves, keyways, sharp fillets or nature of machined surfaces are unimportant in terms of stress raisers and reduced service life, particularly where dynamic stresses are operative. Certain engineering materials are highly susceptible to notch sensitivity as manifest by the cutting of a scratch on the surface of brittle glass or by cutting a sharp notch in soft ductile steel.

The profound effect of a notch in the reduction of the fatigue strength of steel under cyclic fatigue stresses is clearly shown in *Fig.* 3. However the reduction in the endurance limit of Meehanite metal amounts to only about 20 per cent as compared with 50 per cent for steel under similar conditions of test. Meehanite castings exhibit a high degree of freedom from notch sensitivity.

Damping Capacity: This well known property of flake graphite irons is no doubt associated with their low notch sensitivity and the ability of these materials to maintain high resistance to fatigue failure independent of surface discontinuities or surface imperfections. The importance of high damping capacity in damping out stresses caused by vibrations, which can otherwise result in overstresses and permanent damage to the part, is mostly in evidence at the higher torsional stresses where harmful resonant stresses tend to be produced in moving members, *Fig.* 4. Good damping capacity also assures quieter operation.

Antigalling Properties: Galling and seizing is an index of surface disintegration occurring on one of

Fig. 4—Chart showing high specific damping capacity of Meehanite vs. carbon steel at various torsional stresses

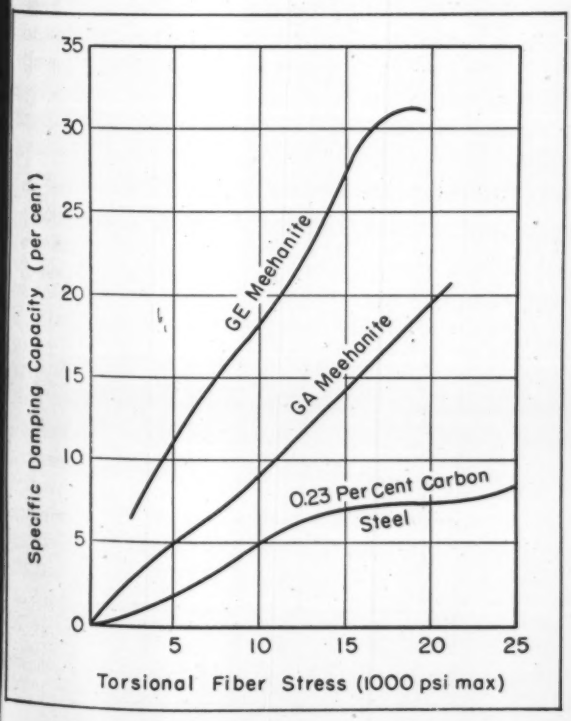
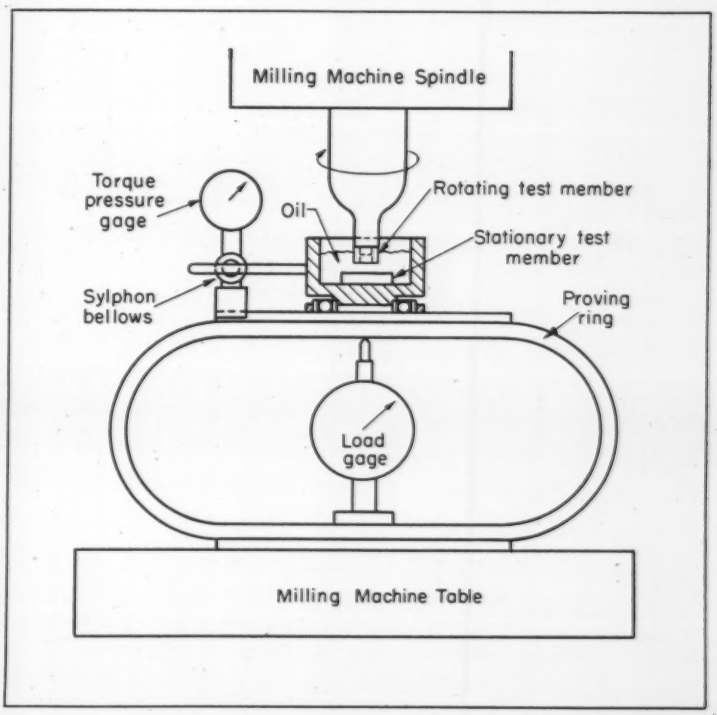


Fig. 5—Test apparatus set up for measuring the bearing qualities of various metals

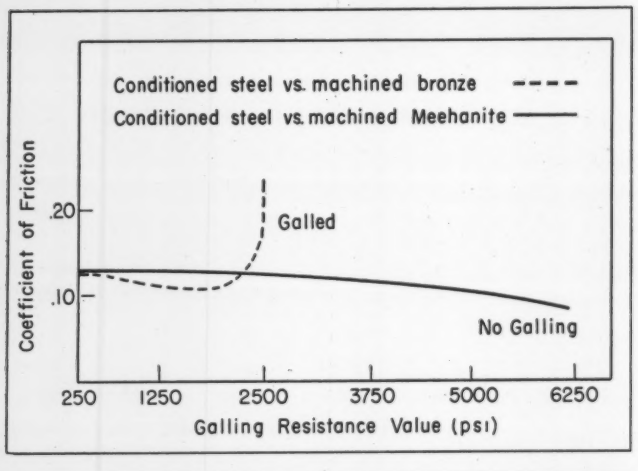


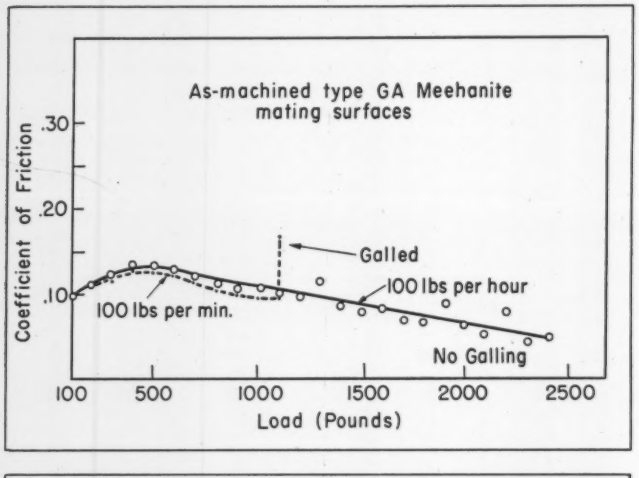
two mating surfaces. The high resistance to galling of Meehanite metal even at high loads, has been thoroughly demonstrated during the past several years by many tests conducted under carefully designed and controlled conditions as well as by service behavior.

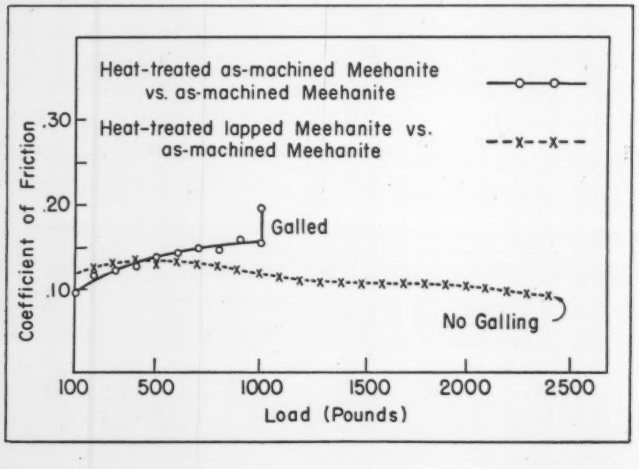
Details of the apparatus used for measuring the bearing qualities of metals is shown in *Fig.* 5. This equipment is essentially a two-gage dynamometer mounted on the table of a vertical milling machine. Tests were made by rotating a hollow cylinder (⅞-inch OD x ½-inch ID), attached to the spindle of the milling machine, against a stationary square block mounted in the dynamometer cup. The surfaces of the test pieces were finished to an accuracy of 0.00001-inch. Surface grease, oil and dirt were removed with trichlorethylene vapor, and the surface rubbed with dry emery. This procedure removed any actual layer of molecular dimensions from the surfaces and exposed a surface free from absorbent layers.

The physical characteristics of the materials were measured and the relative smoothness of the surfaces was determined in rms values by means of a Brush surface analyzer. The surface geometry of the as-machined surfaces recorded by the Brush surface analyzer is indicated by the data included in TABLE 3 which contains the root mean square (rms) values as read from the integrating meter. Examination of the type GE Meehanite and steel surfaces after completion of a wear-in run showed that the steel had apparently undergone the greater change in surface geometry as shown in TABLE 4.

Fig. 6—Charts showing results of tests. Importance of surface character, rate of loading and material combination are evident from the results







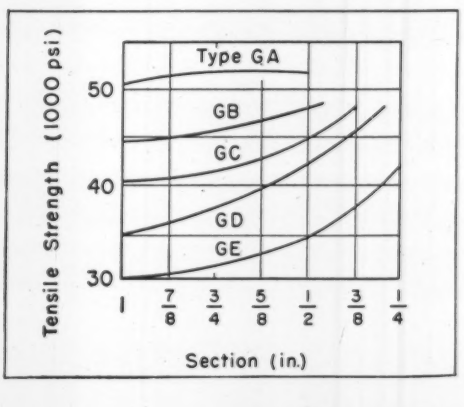
Galling In Terms of Surface Finish

The tests on heat-treated Meehanite metal were conducted on pieces oil quenched from 1580 F and drawn for 30 minutes at 1000 F, giving a final Brinell hardness of 285. Following the heat treatment, the test samples were surface ground to remove any oxidized or decarburized layers and the surface finishes used for study included as-machined, grind finish No. 1, and lapped. The resulting values for surface smoothness obtained by these methods were:

As-machined (stationary member)	90 μ
As-machined (rotating member)	65 μ
Grind finish No. 1	12 μ
Lapped finish	8 μ

Interesting and informative data on galling pressures for various metal combinations in terms of surface finish and coefficient of friction are included in TABLE 5. A few results from actual tests on various mating surfaces are reproduced in *Fig.* 6. These data demonstrate the importance of surface finish and of wear-in periods involving rate of loading as well as load carrying capacity.

CORRECTION: In the article "Section Thickness in Meehanite Castings" (MACHINE DESIGN, Feb., 1951) there was an error in *Fig.* 3, Page 131. The numbers on the section thickness scale should be reversed. The corrected illustration is shown below.



Design Factors for Stress Concentration

Part 2–Notches and Grooves in Tension and Torsion

By R. E. Peterson
Manager, Mechanics Dept.
Research Laboratories
Westinghouse Electric Corp.
East Pittsburgh, Pa.

TERMINOLOGY and general calculation methods were given in Part 1 of this series, published last month; these will not be repeated in this or following data sheets. Examples of grooves in tension are given in *Fig.* 7; illustrations for the bending case shown in *Fig.* 6, February MACHINE DESIGN, also apply in torsion.

Values plotted in *Figs.* 8, 9, 10 and 11 are calculated in accordance with the theoretical work of Neuber.[1] Top curves of *Figs.* 8 to 11 correspond to deep hyperbolic notches (or grooves) and the bottom ones to shallow elliptical notches (or grooves). In between, the values represent an approximation based on both types of notch. However, it has been found that semicircular grooves, V-grooves, straight - sided grooves, etc., are all fairly well approximated by *Figs.* 8 to 11.

For a grooved round bar subjected to torsion, *Fig.* 11, stress-concentration factor K_t and combined stress-concentration and shear-energy factor K_t' turn out to be the same. In torsion, $K_t = \tau_{max}/\tau$, where τ represents shear stresses. In brittle material K_t applies for both the maximum stress theory and the Mohr theory of failure.[2]

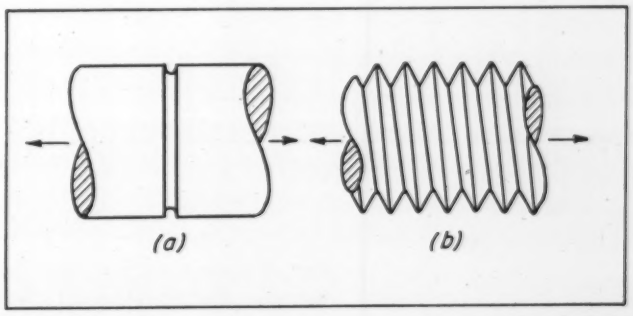
A threaded member, *Fig.* 7*b*, can be considered equivalent to a series of parallel grooves as far as stress-concentration is concerned. A single groove, *Figs.* 8 to 10, is more damaging than a series of grooves. For example, a Whitworth thread contour in a two-dimensional photoelastic model was shown[3] to have a stress concentration factor $K = 3.35$. For a single Neuber groove of comparable dimensions, $K = 4.33$. The ratio of maximum stresses in multiple and single grooves is approximately ¾ for this case. Incidentally, a pronounced difference between the effect of single and multiple grooves is also noted in fatigue.[4] The end thread has a stress-concentration value about the same as a corresponding single groove, a circumstance which should be kept in mind in design. It should be pointed out that there are other factors to be considered in bolted joints, namely, stresses in the bolt at the nut face, where the stress lines make a turn of 180 degrees, and under the bolt head. This subject is beyond the scope of the present article.[3]

The next article of this series, to be published in May, deals with fillets, and will include a curve for the effect of shoulder width. It is believed that this can also be used for closely spaced grooves.

REFERENCES

1. H. Neuber—*Kerbspannungslehre*, Springer Verlag, Berlin, 1937. English translation published by Edwards Co., Ann Arbor, Mich., 1946.
2. S. Timoshenko—*Strength of Materials*, D. Van Nostrand Co., New York, 1942, Part II, Page 711.
3. M. Hetenyi—"The Distribution of Stress in Threaded Connections," *Proc. SESA*, Vol. I, 1943, Page 147.
4. *Proc. ASTM*, Vol 30, Part I, 1930, Page 44.

Fig. 7—Examples of grooved members



Curve sheets appearing in this article, together with additional design data, will appear in a forthcoming book to be published by John Wiley & Sons Inc., New York.

Data Sheet

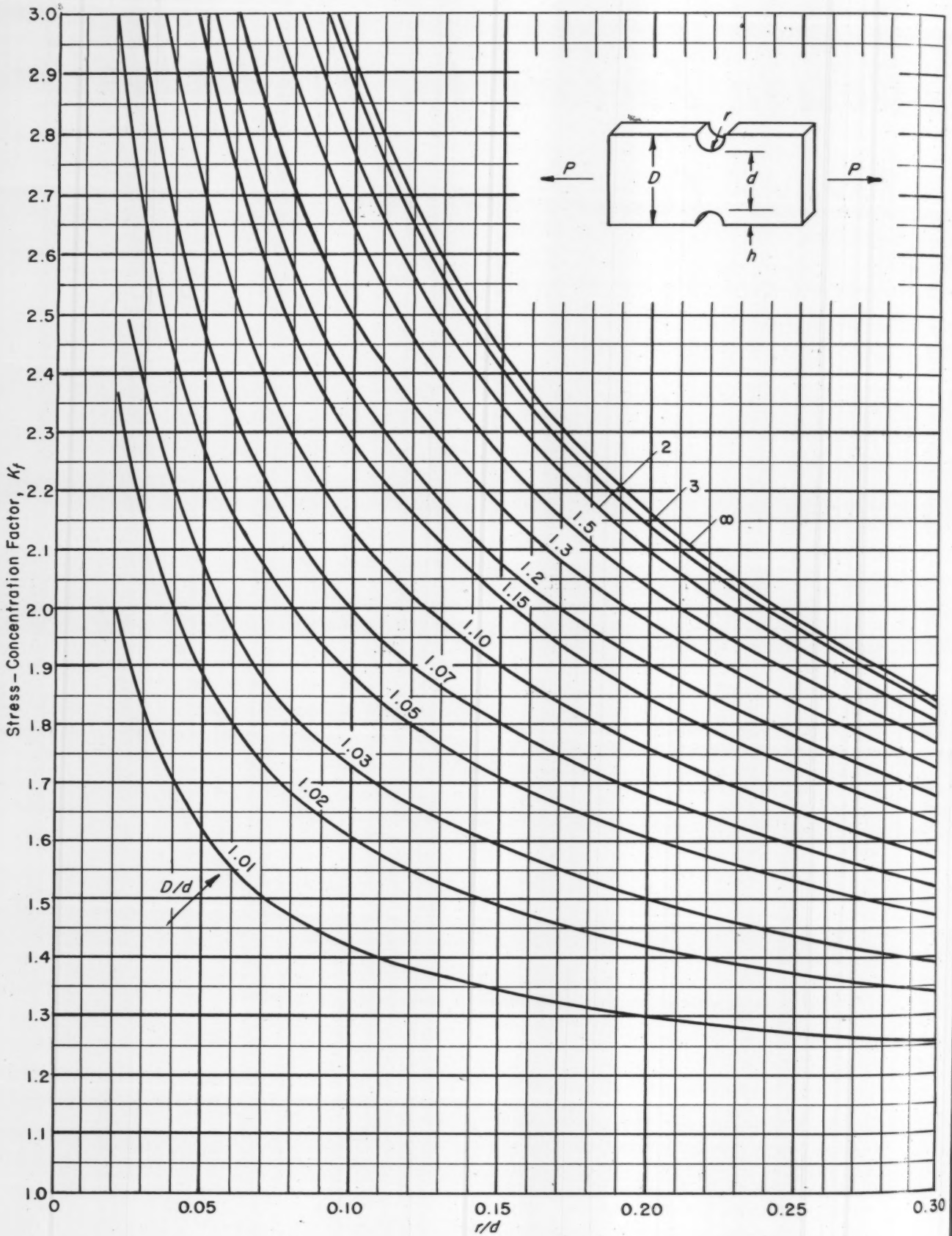


Fig. 8—Stress-concentration factor, K_t, for a notched flat bar in tension. Curves represent values calculated by use of Neuber theory

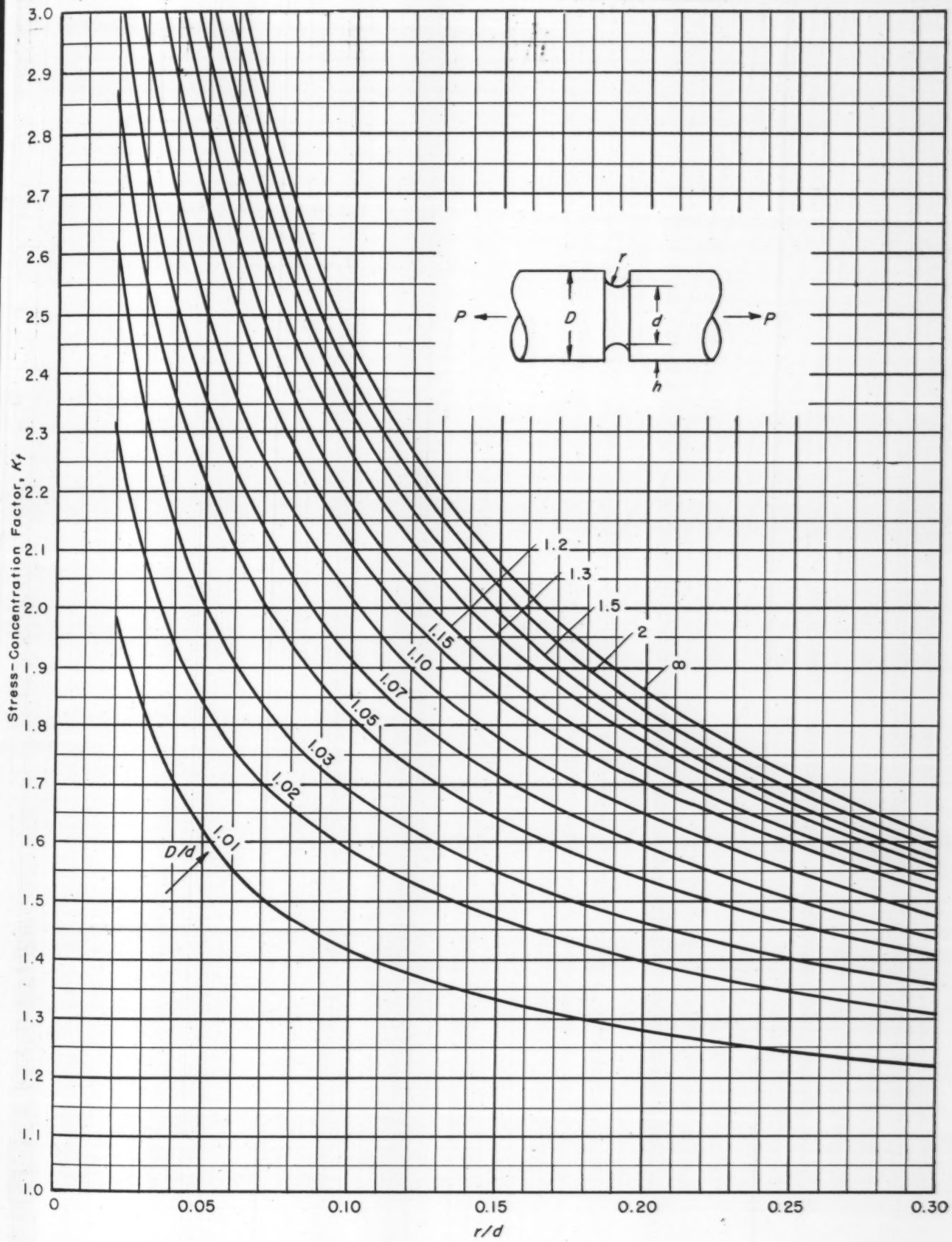


Fig. 9—Stress-concentration factor, K_t, for a grooved shaft in tension. Curves represent values calculated by use of Neuber theory

Data Sheet

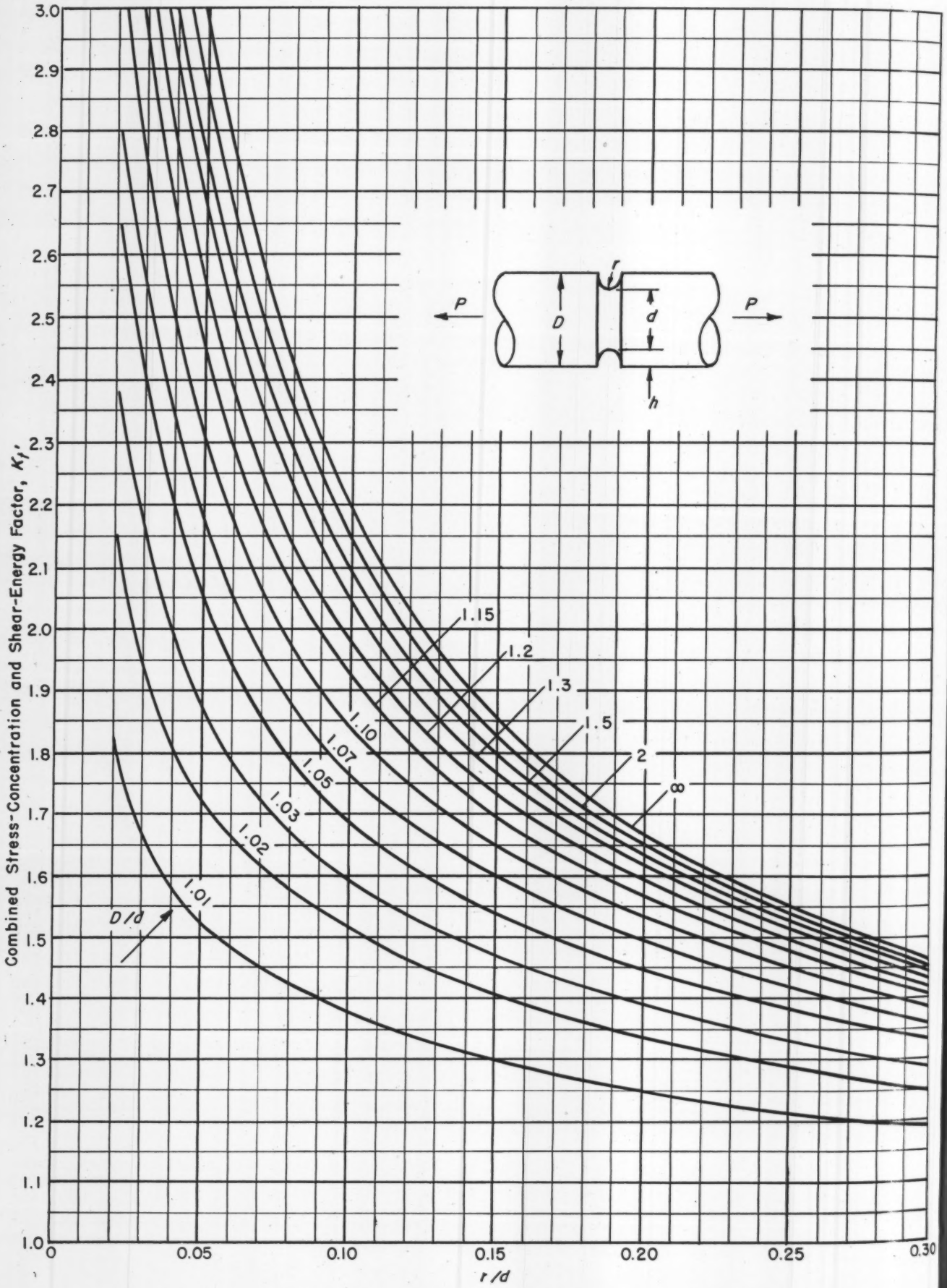


Fig. 10—Combined stress-concentration and shear-energy factor, K_t', for a grooved shaft in tension. Factor $K_t' = mK_t$ where m = factor for shear-energy theory of failure

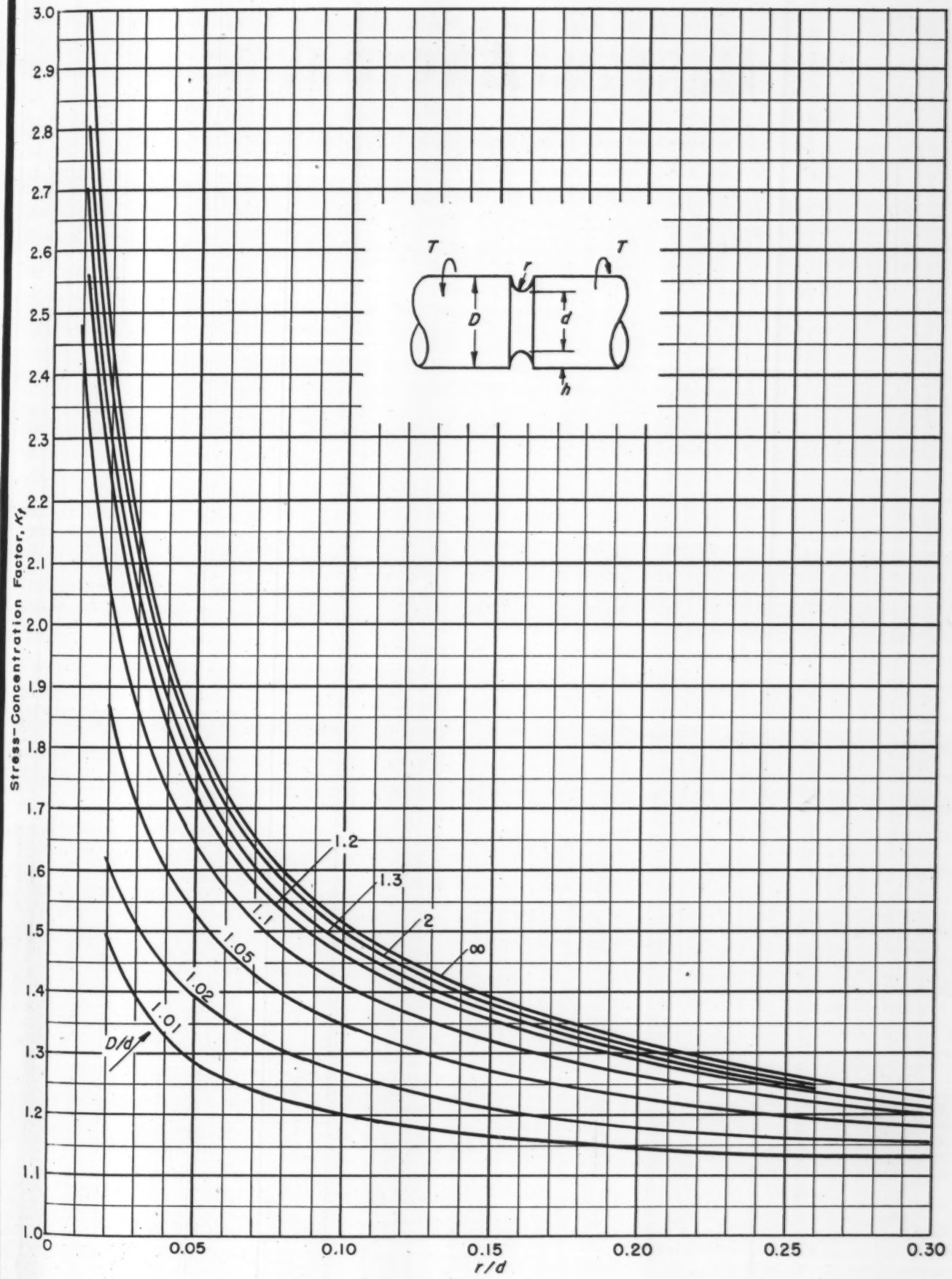


Fig. 11—Stress-concentration factor, K_t, for a grooved shaft in torsion. Curves represent values calculated by use of Neuber theory

DESIGN ABSTRACTS

Stationary Radial Engine

By Donald I. Bohn and Emil Grieshaber
Aluminum Co. of America, Pittsburgh, Pa.
Nordberg Mfg. Co., Milwaukee, Wis.

BUILT with eleven cylinders of 14-inch bore and 16-inch stroke, the Nordberg radial engine, *Fig.* 1, develops 1800 hp or 1250 kw at 400 rpm. The engine is of the two-cycle type with port scavenging and port exhaust; the piston undercovers the ports in the cylinder walls, thereby eliminating intake and exhaust valves. With a welded base the engine is 12 feet wide, 9 feet 4 inches high and weighs 85,000 pounds. It is built as a spark-fired gas engine, as a diesel unit or as a Duafuel engine and has found application as a prime mover for generators, centrifugal pumps and compressors.

One of the unique design features of this engine is the gear train shown in *Fig.* 2. In all radial engines, the rotation of the crankshaft bearing upon which the connecting rods are mounted must be prevented in order to obtain constrained motion of the crank ends of the connecting rods. This is usually accomplished by use of a master connecting rod. However, in the Nordberg radial engine, the master crankpin bearing is prevented from rotating by a planetary gear train which connects the master bearing gear to the stationary crankcase cover. The stationary gear is fastened to the underside of the crankcase cover and is connected to the gear teeth of the master bearing through a unit consisting of a small pinion, drive shaft and larger drive gear. The connecting gear unit is mounted in the upper counterweight of the crankshaft opposite the crank throw. The angular velocity of the master bearing is merely translated by the rotation of the crank.

This type of motion of the master bearing has great practical advantage. Since the center of the master bearing is moving along a circular path, all points on the bearing move along circles of equal diameter. Therefore, the knuckle pins, which correspond to crankpins in the connecting-rod-crank mechanism, describe identical circles. Thus, moving parts of all cylinders are identical kinematically. Consequently, interchangeable parts can be used in all cylinders and timing of the engine is simplified and identical for all cylinders.

Radial arrangement of the cylinders makes possible a perfect static and dynamic balance of the engine. The first order inertia force to be balanced equals the sum of the inertia force of the rotating masses of the engine and one half that of the reciprocating. This total force acting in the direction of the crankthrow can be completely balanced by the counterweights because there are no free forces or moments transmitted to the foundation of the engine. All higher inertia forces are inherently balanced without counterweights. Thus the engine is free of vibrations and requires only a light

Fig. 1 — Spark-fired gas-burning version of Nordberg radial engine

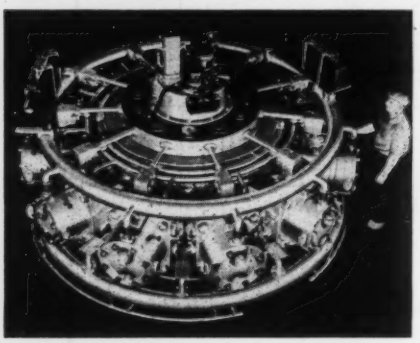
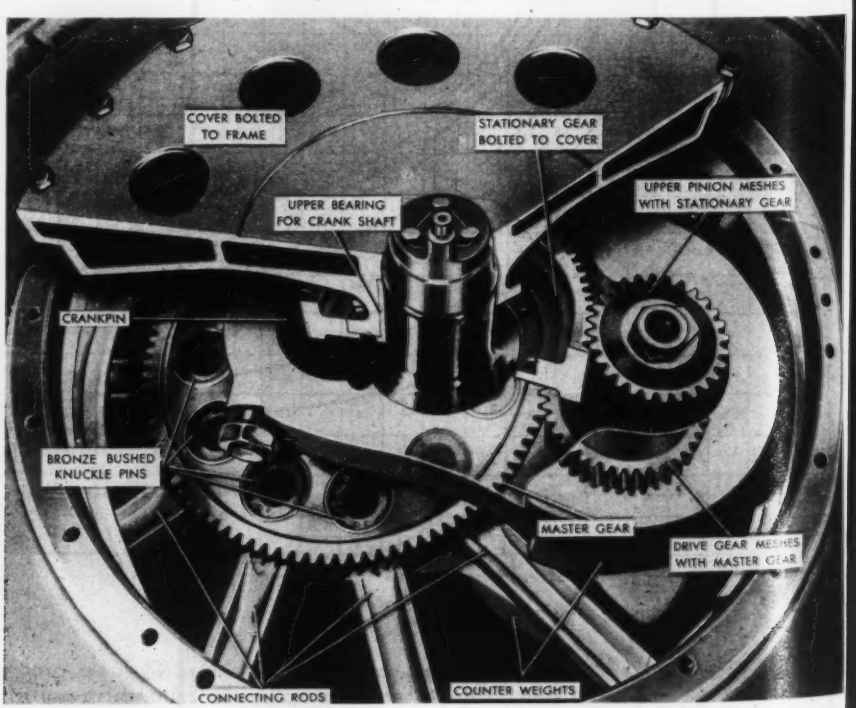


Fig. 2—Top view of crankcase showing planetary gear train which prevents rotation of the master crankshaft bearing, thereby constraining the motion of the connecting-rod crank ends



oundation. The problem of torsional vibrations is simplified because of he high natural frequency of the tiff single-throw crankshaft. Most f the orders that are familiar to esigners of in-line engines are elimnated in this engine because of the adial attachment of the moving arts of the cylinders to a single rank. In applications requiring long hafts where several modes of torional vibration are possible, the umber of critical speeds is reduced o a minimum; this simplifies the limination of torsional vibrations within a wide operating range.

The two-piece crankshaft is high-ensile cast iron. It has two bearings of the babbitted-bronze shell ype, the lower one being in the cenral hub of the crankcase, the upper in the crankcase cover. The low-ection of the crankcase comprises he short shaft, lower counterweight and crankpin. A polished thrust face on the underside of the counterweight rides on the eight tilting pads of the thrust bearing which supports the weight of the shaft assembly. With the master gear in position on the crankpin, the upper section, consisting of the upper counterweight, is attached to the lower section by doweling and clamping for rigid assembly. Pistons are aluminum alloy forgings, as are the ring carriers which are shrunk over the upper portions of the pistons. They carry the piston rings and also provide passages for the piston cooling oil. Wrist pins are the floating type. Connecting rods are one-piece forgings. Knuckle pins are tightly clamped into the crankend eyes of the rods and are carried in two bearings located in the two flanges of the master gear. All bearings are one-piece bronze bushing type; no split shells are used.

From a paper entitled "Design Features of the Nordberg Radial Engine," presented at the Oil and Gas Power Conference of the ASME, Baltimore, Md., June 12-16, 1950.

Designing Metal-Powder Parts

By D. C. Bradley
The New Jersey Zinc Sales Co.
New York, N. Y.

AS IN any process, there are general rules which may be applied in designing for powder metallurgy. However, these suggested rules should not be allowed to take the place of consultation with the powder-metallurgical engineer or fabricator. His experience remains invaluable in arriving at the design which best meets the requirements of utility and appearance and, at the same time, lends itself to economical production by the process. Hence he should be consulted as early as possible when designing parts for powder metallurgy.

Among the basic considerations in design are the properties of the material and the limitations of the fabricating and finishing processes to be used. Powder-part fabricators are ingenious in designing dies and producing parts, but they are subject to limitations in what they can do. Modern pressed-powder parts have useful properties, and skillful design consists in making the most of these properties.

The majority of structural powder parts are porous to some extent. The exact amount of porosity depends on such factors as the compacting pressure, sintering time and temperature, and on subsequent coining or repressing operations. It should be remembered that the powder metallurgist has fewer restrictions placed upon him as regards composition. He can press a part from iron powder and, by impregnating it with molten copper or brass, eliminate most if not all porosity. By such treatment it is possible to obtain tensile strength in excess of 75,000 psi. Iron parts can be hardened by standard methods or by variations of them, and Rockwell C values as high as 60 to 65 have been obtained consistently.

Actual design of a part is governed by the characteristics of metal powders and by die and press limitations. For example, undercuts are impractical. The situation is different than in die-casting, where holes can be cored in almost any direction and threads usually can be cast. Because of the flow, or rather, the lack of flow, any coring in a powder part must be parallel to the direction of pressure application. Threads, representing undercuts, are impossible to press in place. One notable exception to this rule, and it is a special case, is in helical gears. Two fabricators have developed methods whereby they can produce gears successfully with a maximum helix angle of 26 degrees.

Density Variation Limits Design

Another factor presented by poor flow is variation in density within a given part. The simplest example of this is cylinders. With pressing from one end only, the density is found to be greatest at the outer edge of the end immediately adjacent to the punch. The density at the other end will be less, but greater at the center than at the edge. With pressing from both ends, lowest density will be found at the outer surface midway between the ends. This phenomenon puts a limitation on the length-to-diameter ratio, since, if the ratio is too high, the part will have insufficient strength through the center portion. Also, the shrinkage which will take place during sintering — being governed in part by density— will be uneven. The general rule is that length to diameter should not exceed 2½ to 1. There are exceptions, but those, in general, are cases where the strength of the center section is not too significant.

Powders obviously are compressed during pressing—how much depends on the specific powder used and on the compacting pressure. Since powders will not flow appreciably under pressure, wide variations in section thickness can cause trouble.

Practical Sizes of Parts

How small can a part be and remain practical? The ultimate in smallness depends on the ability of the powder to fill rapidly and evenly all parts of the die in the allotted time. The lower limit appears to be between 0.02-inch and 0.03-inch in the dimension perpendicular to the direction of pressure application.

How large a part may be depends partly on the size of the available press equipment. It requires from 30 to 50 tons pressure per square inch to form most structural parts. As presses become larger, they become slower, and some of the advantage of speed is lost. Probably more important, as size increases, problems which can be ignored in small parts become increasingly critical. Differences in density which will cause variations in shrinkage may cause warpage or cracking and, as a result, more complex dies are required to reduce density variations to a minimum.

Powder metallurgy has a great ad-

(Continued on Page 206)

MEN OF MACHINES

William G. Gerstacker has been appointed chief engineer of the Colonial Iron Works Co. Prior to his present appointment, he was associated with the V. D. Anderson Co. as manager of the Solvent Extraction Division. A graduate of Case Institute of Technology, Mr. Gerstacker brings to his new position more than fifteen years of experience in metal fabrication industries, having been an engineering estimator with The Pfaudler Co., and a development mechanical engineer with Union Metal Mfg. Co. before joining the V. D. Anderson Co. Mr. Gerstacker was an instructor in strength of materials, machine design and engineering physics for the Engineering, Science Management War Training program of the U. S. Office of Education.

William G. Gerstacker

♦

Towmotor Corp. announces the appointment of **E. C. Iverson** as chief engineer. Mr. Iverson is well known throughout the engineering field and has been associated with the J. D. Adams Mfg. Co. in charge of all product design and development. Mr. Iverson is active as a member of the Society of Automotive Engineers.

E. C. Iverson

♦

Maurice Nelles has been appointed director of Borg-Warner's engineering development section. Dr. Nelles previously was director of the Engineering Experimental Station and professor of engineering research at Pennsylvania State College. In his new position, he will head Borg-Warner's product development and research laboratory in Bellwood, Ill. During the last war, Dr. Nelles was deputy director and chief engineer of the War Production Board. He also has been engineering and research manager of the Hancock Foundation at the University of Southern California and senior research engineer of the Lockheed Aircraft Corp.

Maurice Nelles

♦

Westinghouse Electric Corp. announces the appointment of **Clarence Lynn** as engineering manager of the Atomic Power Division. Mr. Lynn joined the company in 1919 as a graduate student and entered the Power Engineering Department the following year as a designer of d-c motors and generators. In 1928 he was made section engineer in charge of the design of dc motors and generators. When the Transportation and Generator Division was formed in 1938, Mr. Lynn was made manager of the DC Engineering

JOHNSON BRONZE

SLEEVE BEARING DATA

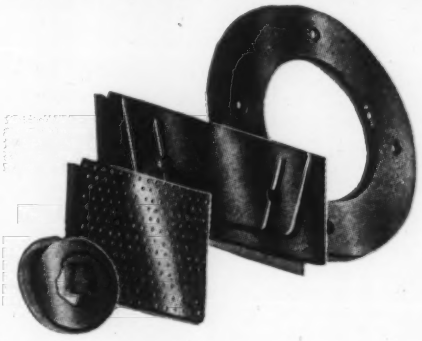
Bearing TYPES

JOHNSON BRONZE

SLEEVE BEARING DATA

Sheet Metal Bearings-2

Pre-Cast Bronze-on-Steel



WHILE this is a comparatively new type of bearing material, developed and patented by Johnson Bronze, millions of bearings and parts now in constant use provide definite proof of its excellent qualities.

Pre-Cast Bearing BRONZE-ON-STEEL is essentially a thin wall, laminated type of bearing that combines the bearing qualities of a high grade bronze alloy with the strength of steel. We start with a mixture of copper, tin and lead which is universally accepted as the best general purpose bearing bronze available. It combines, in the correct proportion, all the necessary elements to insure the utmost in bearing performance.

By casting this alloy in solid bronze bars we unite the metals chemically and form a definite copper-tin eutectic—with the lead trapped in the interstices. Thus the grain structure of the alloy—and the resulting bearings—is definitely established. Next, we reduce the bronze bar to a fine powder, about the same consistency as talcum. This powdered bronze is then treated in a hydrogen furnace to remove all oxides and then firmly bonded to copper coated strip steel. The process of manufacturing bearings from BRONZE-ON-STEEL, in strip form, is the same as for any other type of sheet metal bearing, being essentially a stamping and forming operation.

Bearings are made from this material in the same manner as bronze sheet metal bushings. The range of wall thickness is between .031" to .110". Lengths of bearings cannot exceed 4½". The smallest I.D. which can be formed is ⅜". Steel thickness for .052" wall bushings is .036"; for .070" wall it is .050" thick.

BRONZE-ON-STEEL is assembled by the same methods ordinarily used for bronze metal. It can be burnished with ordinary tools. It is also possible to bore and ream this material, but special carbide tipped tools are necessary. Diamond boring is sometimes recommended as a finishing operation.

Chemical and Physical Properties of Bronze-on-Steel

CHEMICAL ANALYSIS	Plain Bronze	Graphited Bronze
Copper	Balance	Balance
Tin	8-11	8-11
Lead	8-11	8-11
Graphite	none	1.0 max.

PHYSICAL PROPERTIES

	(1) Rockwell Hardness E Scale	(2) Wear Rate	(3) Coefficient of Friction	(4) Resistance to Pounding	(5) Resistance to Pounding
Plain Bronze	55 min.	0.09	0.14	64	447
Graphited	55 min.	0.02	0.13	57	255

1. Rockwell Hardness, E scale 100 Kg. Load—⅛" ball.
2. Wear Rate Loss of weight in grams—1 hour run, 1" I.D. bushing at 400 R.P.M.—.005" clearance—25 lb. per sq. in. pressure—no lubrication.
3. Coefficient of Friction—as determined on J. B. Machine. No lubrication.
4. Resistance to pounding—number of blows of 60 lb. hammer falling 2" to deform specimen .001"—1" x 1" x 1/16" specimen.
5. Same as (4) with deformation going to .005".

Specifications

	Standard Wall Thickness	For Shaft Diameters
1.	.032—.035	From 5/16" to 1½" Shaft
2.	.042—.045	From ⅜" to 1¾" Shaft
3.	.062—.065	From ⅝" to 2¾" Shaft
4.	.092—.095	Over 1¼" Shaft

In order to obtain the best results from Pre-Cast Bearing BRONZE-ON-STEEL bushings and bearings, it is advisable to include the following information in your specifications:

1. SIZE of hole bushing is to be pressed into—rather than O.D. of bushings.
2. SIZE I.D. required after pressing into place. Manufacturers standard tolerance .002.
3. TYPE of body or housing bushing is pressed into.
4. SPECIAL FEATURES of bushing should be fully explained including their purpose.

Thrust Washers

While BRONZE-ON-STEEL was developed primarily for Bushings and Bearings it also fills many other important industrial uses. It is ideal for applications requiring a flat bearing surface such as plates, washers, etc.

Some manufacturers prefer to purchase BRONZE-ON-STEEL in rolls and do their own stamping and forming. For such cases we can furnish it in rolls up to 400 feet in length. The maximum width of the strip cannot exceed 6½ inches.

●

This bearing data sheet is but one of a series. You can get the complete set by writing to—

Johnson Bronze

SLEEVE BEARING HEADQUARTERS
525 S. MILL ST. • NEW CASTLE, PENNA.

Department. In 1941, Mr. Lynn was awarded the Westinghouse Order of Merit for his outstanding engineering accomplishments.

♦

Sheldon E. Young, formerly assistant chief engineer, has been appointed manager of field engineering service of the Barry Corp. In this capacity, Mr. Young will co-operate with designers and project engineers in the analysis and solution of shock and vibration problems.

♦

Charles Bangert Jr. has been appointed manager of engineering for the Trumbull Electric Mfg. Co. Mr. Bangert joined Trumbull in 1947 as design engineer. In October 1950 he became assistant manager of engineering. In his present position, Mr. Bangert will be in charge of all engineering activities.

♦

William J. Fleming, former vice president in charge of engineering of the Trumbull Electric Mfg. Co., has been appointed vice president in charge of engineering and manufacturing of the General Electric X-Ray Corp. in Milwaukee, Wis.

♦

Walter Geist, president of Allis-Chalmers Mfg. Co., died January 29. Among his many honors, Mr. Geist was awarded the plaque of the "Modern Pioneer" in recognition of his part in the development of the multiple V-belt drive. He also received a doctor of engineering degree from the Michigan College of Mining and Technology, and was further honored in April, 1950 when he was presented with the Knights Cross, First Class, The Royal Order of St. Olav, by King Haakon VII of Norway. This is one of Norway's highest awards.

♦

David Sloane has been appointed vice president in charge of engineering development of the Lester Engineering Co.

♦

Albert A. Goodman has been appointed manager of quality control for the Philadelphia division, Yale & Towne Mfg. Co. Prior to joining Yale & Towne, Mr. Goodman was supervisor of quality control for the Westinghouse Electric's Steam division.

♦

Frederick G. Riedel has been appointed chief engineer of the United States Air Conditioning Corp. Mr. Riedel formerly was chief engineer and works director of research at the Holyoke Works, Worthington Pump & Machinery Corp.

♦

R. E. Lucey has been elected a vice president of the Trane Co. Mr. Lucey continues as manager of product development.

♦

Frank Hallberg has been appointed chief engineer of the Ross Operating Valve Co. Mr. Hallberg has wide experience in the development of machine equipment. He was previously connected with the Clinton Machine Co. and was formerly chief engineer of the Detroit Industrial Co. Mr. Hallberg was also design engineer for the Progressive Welder Co. and the Federal Machine & Welder Co. for a number of years.

♦

Westinghouse Electric Corp. announces the appointment of **A. M. Harrison** as manager of the DC Engineering Dept. of the company's Transportation and Generator Division. Prior to this appointment, Mr. Harrison was manager of the D-C Machine Section of the same department.

♦

John L. Galt has been appointed manufacturing engineer of the General Electric Chemicals Division Phenolic Products plant. Mr. Galt will be responsible for the supervision of process engineering, plant engineering and quality control in the manufacture of magnesium oxide, resins, etc.

♦

Dean Hammond has been appointed vice president of engineering of the Kaiser-Frazer Corp. He will direct engineering for the company's aircraft defense contracts as well as automotive development. S. W. Taylor has been appointed to the newly created post of executive engineer.

♦

David Rau has been appointed chief engineer of RCA Communications Inc. Mr. Rau was formerly vice president in charge of engineering.

♦

Dr. E. A. Lederer has returned to Westinghouse Electric as manager of engineering for the newly-created Electronic Tube Division, Bloomfield, N. J. Dr. Lederer has had wide experience in the engineering, design, and development of electronic tubes.

♦

Karl T. Compton has been awarded the 1950 Hoover Medal for distinguished public service, as a great leader in engineering education who has had a profound influence on the development of science and engineering.

♦

Casimir S. Kopec has joined the American Gear Manufacturer's Association as staff engineer. Mr. Kopec was formerly associated with the General Motors Corp. and the Ford Motor Co. Research Laboratories, specializing in gear design.

♦

W. G. Miller has been appointed manager of manufacturing for Westinghouse Electric Corp.'s Motor and Control Division, Buffalo, N. Y.

♦

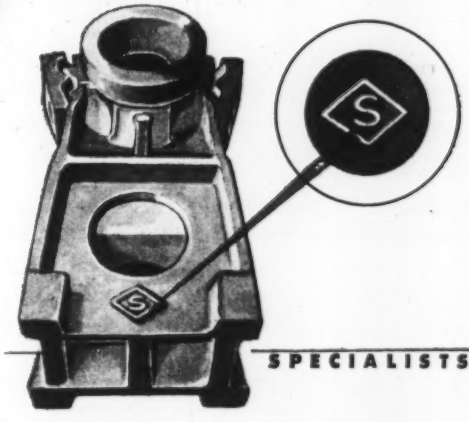
Donald B. Harris has been appointed technical assistant to the president of Airborne Instruments Laboratory, Mineola, N. Y. Mr. Harris was formerly executive assistant to the director of research of Collins Radio Co.

Coddled CASTINGS

Like a doting parent — each Sivyer craftsman takes pride in the birth and growth of a casting. From molten metal to finished product, each casting is anxiously watched, inspected, x-rayed, calipered, and educated to its pattern destiny by scientist and engineer alike. This "coddling" might spoil a child, but in a casting it is your best assurance of accuracy, long life and trouble-free performance. (Have a cigar?)

how to identify better steel castings

"Good breeding tells", says the old axiom. We believe it's particularly true of castings. So look for the Sivyer Ⓢ ... your guarantee of better high alloy and specification steel castings.



SIVYER

SPECIALISTS IN HIGH ALLOY AND SPECIFICATION STEEL CASTINGS

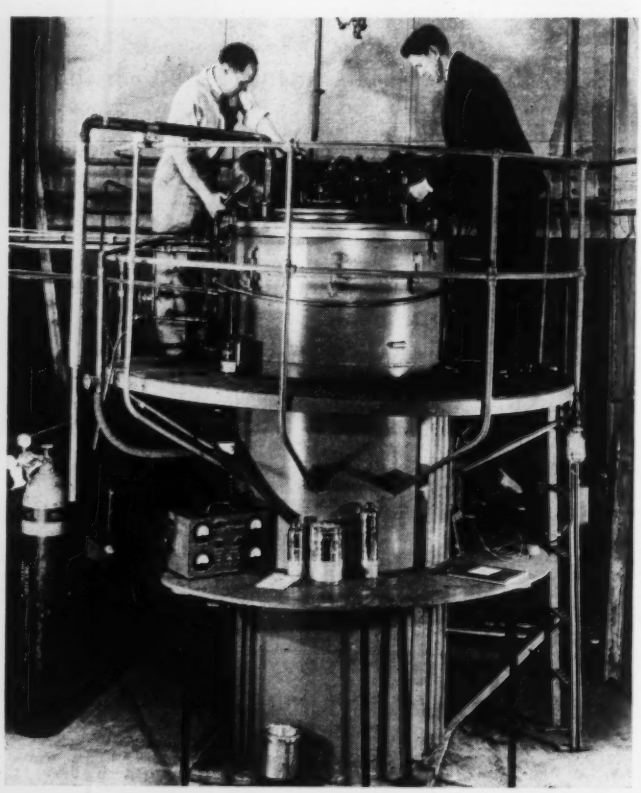
SIVYER STEEL CASTING COMPANY • MILWAUKEE Ⓢ CHICAGO Ⓢ

Helium Engines Cool Super Freezer

A 15-CUBIC-FOOT super freezer which cools its contents to −452 F and holds them there indefinitely is now in operation at the Massachusetts Institute of Technology. The largest, coldest box known, it will open the world of low-temperature research to studies on a scale never before possible. Technically called a "cryostat," the new machine was designed and built by Dr. Samuel C. Collins, professor of mechanical engineering, in the M.I.T. low-temperature research laboratories with funds provided by the Navy Bureau of Ordnance and Office of Naval Research.

The new machine operates by compressing, regeneratively cooling, and then expanding helium gas until a portion of the gas turns into a liquid just 7½ F above absolute zero, the lowest theoretically possible temperature. The new machine fulfills for the first time the need for a large refrigerated space in which heavy equipment can be cooled and studied at lower temperatures than ever before possible. It provides a cylindrical working space 30 inches in diameter and three feet deep.

As temperatures approach the theoretical lower limit of absolute zero, many substances take on novel and thus far unexplained mechanical and electrical properties. In some, resistance to electric current vanishes completely, giving rise to the phenomenon known as "superconductivity." The strength and brittleness of other materials change radically at this heat-less temperature. The new cryostat will be used in research on the mechanical properties of metals, where studies at extreme low temperatures may yield information on strength theory which will in turn be useful in designing metals for greater strength at conventional temperatures.



Actual cooling is accomplished by five expansion engines driven by compressed helium in much the same way more conventional engines may be driven by high-temperature steam. The helium gives up its heat to provide the energy used to move the engine, and the cold exhaust helium, when brought into contact with a stream of compressed gas, causes the latter to liquefy. Five "helium engines" operate in tandem but at different temperatures. The helium gas is compressed to 180 psi and cooled by water before being fed into the parallel tubes of a counterflow heat exchanger. This device, designed to move heat from one part of the engine system to another, contains two long gas passageways. One distributes water-cooled compressed helium to the intakes of the five engines spaced along its length. The second collects the exhaust gas from the engines, which is much colder than the intake gas because of the work it has done, and conveys it back to the water-cooled compressor. On the way back, the cold "exhaust" gas absorbs heat from the neighboring incoming compressed helium, and there is enough refrigeration left over to liquefy a small part of the latter.

Lubrication Impossible at Low Temperatures

To build such "helium engines" is no simple mechanical problem, because there are no effective lubricants at the operating temperature of liquid helium. Pistons of extreme hardness are used in the machine, fitting the cylinders so closely (0.0002-inch) that piston rings are not needed. Piston rods, which range up to seven feet in length, are flexible so that the pistons "float" in the cylinders. Liquid helium produced by the machine collects at the bottom of the refrigerated cylinder, from where it may be drawn off as needed for other equipment. During operation, temperature of the helium atmosphere in this eight-foot-high cylinder ranges from that of the surrounding room, at the top of the cylinder, to that of liquid helium, within three feet at the bottom of the cylinder.

A vacuum insulates the entire machine and refrigerated space from room temperatures. Pressure in this evacuated space must be maintained at below one millionth atmosphere for satisfactory insulation.

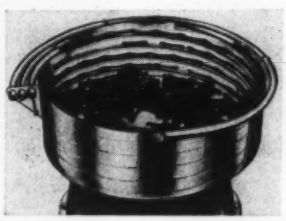
NEW PARTS

AND MATERIALS

. . . presented in quick-reference data sheet form for the convenience of the reader. For additional information on these new developments, see Page 185

Parts Feeder 1

Syntron Co., 260 Lexington Ave., Homer City, Pa.



Style: Automatic vibratory, single-line; models EB-0 and EB-1 two feed tracks; EB-2, EB-4 and EB-5 to four feed tracks

Size: Bowl diameters, 10-in. (EB-0), 15-in. (EB-1), 24-in. (EB-2), to 6 ft. (EB-4 and -5); respective size of parts handled 1¼, 3, 4, and 8 in.

Service: Power required 20, 100, 250, 1000, and 2600w respectively; current 110/220v 60 cycle (EB-0), 110/220/440v 60 cycle (EB-1 and -2), 220/440v 60 cycle (EB-4 and -5)

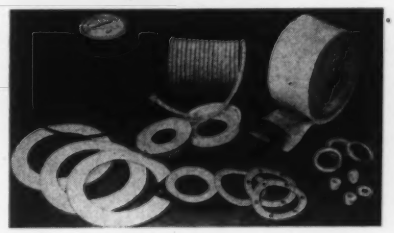
Design: Selective feeding with regard to piece position; feed to left or right with single, double, or multiple discharge troughs; electromagnetic driving mechanism with flow-rate control—operating switch and rheostat or reactor—smaller models (EB-0 and -1) built-in controls, larger models wall mounted; bowls cast aluminum, stainless steel or sheet steel

Application: For automatic feeding and orienting of washers, grommets, bushings, roller bearings, preforms, pulley wheels, gears, stampings, etc., to fixtures of machines for processing or assembling.

For more data circle MD 1, Page 185

Packings and Gaskets 2

Garlock Packing Co., Palmyra, N. Y.



Form: Coil and ring (5733); ring, sheet, gasket, tape, and cup (8764); coil and ring (9166)

Size: 5733—⅛ in. and larger packing sizes; 8764—(sheet) 10 x 10, 10 x 20 and 20 x 20 with 1/32 to 1½ in. thickness or 12 x 12, 12 x 24 and 24 x 24 with 1/32 to 1¼ in. thickness—(tape) ¼ to 2 in. wide 0.002-in. thick, ¼ to 12 in. wide 0.003, 0.004, 0.005, and 0.010-in. thick, ½ to 12 in. wide 0.015 to 0.060-in. thick in 0.005 increments—(cups) max OD 21 in.—(gaskets and disks) cut from sheet or tape up to 21-in. diam.—(ring) solid molded Chevron, V and other shapes to suit; 91.66—(coil) 5/32 round, ¼ x 5/16 to ¾ x ⅞ rectangular, 1 in. square—(rings) solid die-formed ⅜ to 10 in. ID, ⅝ to 11½ in OD, ⅛ to 1 in. packing space

Service: Corrosive chemicals, acids, alkali solutions and organic solvents from below −90 F to 500 F—sulphuric, chromic and hydrofluoric acids, bromine, chlorine, fluorine, hydrogen peroxide etc.

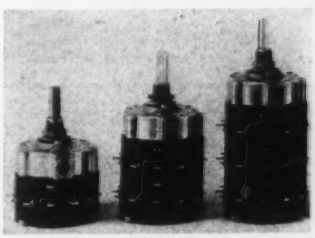
Properties: Do not react with construction metals; affected by molten alkali metals; low coefficient of friction at normal operating temp; low electric power factor, insulating

Application: Seal for valves, pump rods or shafts, flanged joints, etc., of fluid handling systems particularly in chemical processing.

For more data circle MD 2, Page 185

Selector Switch 3

Leeds & Northrup, 4934 Stenton Ave., Philadelphia 44, Pa.



Style: Type 31-3, rotary, wafer shorting switch; panel mount; totally enclosed

Size: Overall diameter including solder terminals 2 in., depth 1⅝ in. (1-pole) through 5$\frac{7}{16}$ in. (6-pole)—behind panel $\frac{15}{16}$-in. plus $\frac{1}{16}$ in. per pole; dial 2½ in. diameter; 2 hole mounting per JAN and RMA stds.

Service: 12 position, 1 to 6 poles; current interrupting capacity 1 amp at 110 v 60 cycle resistance load; contacts carry continuous current of 5 amps; thermal emf less than 1 microvolt at normal switching speed; voltage breakdown greater than 500 v rms between switch points or from any switch point to ground; max inductance 0.03 microhenry; capacitance between segments 0.5 micromicrofarads; contact resistance 0.001 ohm

Design: Brushes make contact with next segment before leaving previous one; switch detent adjustable by screw from loose to stiff operation; switch body molded plastic with die-cast aluminum base and bronze bearing insert; stationary contacts solid silver, brushes silver alloy

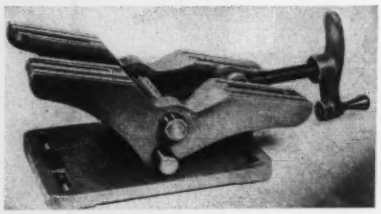
Application: For selecting in multiple electrical instrument circuits.

For more data circle MD 3, Page 185

NEW PARTS AND MATERIAL

Tilting Motor Base 4

Lovejoy Flexible Coupling Co., 5217 *West Lake St., Chicago* 44, *Ill.*



Style: Adjustable, tilting

Size: 5½ x 7 in., 10 lb.

Service: Controls belt tension or speed with variable-speed pulleys; mounts all fractional-horsepower motors

Design: Adjustable width and length; position control by handle screw adjustment; changes can be made with connected machine in operation

Application: For mounting fractional-horsepower drives employing variable-speed pulleys or cone-step pulleys to secure proper belt tensioning.

For more data circle MD 4, Page 185

Zinc Plate Treatment 6

Allied Research Products Inc., 4004-6 *E. Monument St., Baltimore* 5, *Md.*

Designation: Iridite No. 12 (Brite zinc seal)

Form: Chromate treatment in concentrated solution, one unit 12½ gal (637½ gal working solution)

Service: Bright protective, chrominum-like finish for bright zinc plated surfaces; simple chemical dip with standard finishing equipment; minimum zinc plate thickness 0.0002 to 0.0003-in.

Properties: Corrosion - resistant, bluish bright, passive surface; requires no bleach; does not polish; operating pH range 0.3 to 0.6; operating acid no. approximately 20; immersion time 5 to 15 seconds

Application: For sealing and imparting a chrome-like appearance to bright zinc plated surfaces which may be substituted for chromium or other more expensive metals. Replaces cadmium where soldering is not necessary.

For more data circle MD 6, Page 185

Induction Motor 8

Fairbanks, Morse & Co., Chicago 5, *Ill.*

Style: QZE, totally enclosed, nonventilated

Size: 7½ and 5 hp; NEMA standard frame 284

Service: 1800 (7½ hp) and 1200 (5 hp) rpm.

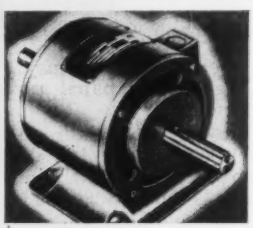
Design: Squirrel cage, windings one piece homogeneous copper alloy centrifugal casting; cartridge type ball bearings with grease space ample for lifetime seal, provision for flushing and regreasing; reversible recessed conduit box

Application: For machine drives subjected to dirt, dust, abrasive particles, corrosive gases, etc.

For more data circle MD 8, Page 185

Magnetic Transmission 5

Vickers Electric Div., Vickers Inc., 1815 *Locust St., St. Louis* 3, *Mo.*



Style: 32D38, stationary, external coil; foot mounted

Size: 10 7/16 in. to shaft ends, 6¼ in. high including base, 6¾ in. wide including conduit box; housing diameter 5½ in.; weight 21 lb.

Service: 4000 rpm max; 85C (40C ambient) temp rise of coil; on-off service—160 oz-ft torque, 820 amp-turn d-c coil excitation, 35 w coil power; slip service—100w slip dissipation, 32 oz-ft torque, 550 amp-turn d-c coil excitation, 20w coil power; reversing 0.5 to 3 hp

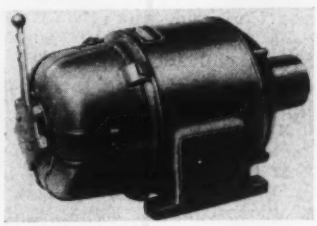
Design: Magnetic particle clutch; driven from either end by belts, gears, etc.

Application: For controllable coupling, clutching and braking of power drives in machines requiring accurate response to torque, speed or position.

For more data circle MD 5, Page 185

Adjustable-Speed Motor 7

Star-Kimble, Motor Div. Miehle Printing Press & Mfg. Co., 200 *Bloomfield Ave., Bloomfield, N. J.*



Style: Type LK, adjustable-speed repulsion; foot mounted

Size: 1/6 to 3 hp; NEMA standard frames 201, 203, 204, 224, 225, 254, and 284

Service: Continuous duty, variable speed; single phase, a-c

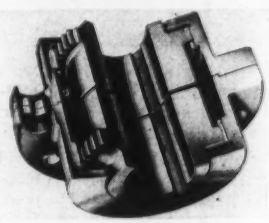
Design: Brushes shifted by lever on commutator end; direction of rotation determined by movement of lever from neutral; moving brushes away from neutral increases speed; all motors suitable for belt drive, up to and including ½ hp suitable for friction drive also; Press-O-Matic remote control with speed selector scale and push button starting and stopping, foot control, or autotransformer voltage control

Application: For variable speed drives requiring relatively constant torque suitable for manual control such as centrifuges, driers, spinning machines, coil winders, conveyors, etc.

For more data circle MD 7, Page 185

Gear Coupling 9

Flexible Gear Coupling Co., Erie, Pa.



Designation: Amerigear

Style: Models GL (double engagement), GLS (single)

Size: Nominal max bore 1, 1¼, 2, 2½, 3, 3½, 4, 4½, 5, 5½, and 6 in. absolute max bore 1⅛, 1⅜, 2⅛, 2⅝, 3 3/16, 3¾, 4¼, 4¾, 5½ 6 and 6⅝ in. respectively; horsepower per 100 rpm 2.1, 3.5, 11, 25, 45, 80, 120, 180, 250, 350, and 450

Service: GL offset, angular, or offset and angular misalignment, GLS angular misalignment only; max speed (thousands rpm) 12.0, 11.0, 10.0, 9.3, 7.9, 6.75, and 6.0, 5.3, 4.75, 4.3, and 4.0

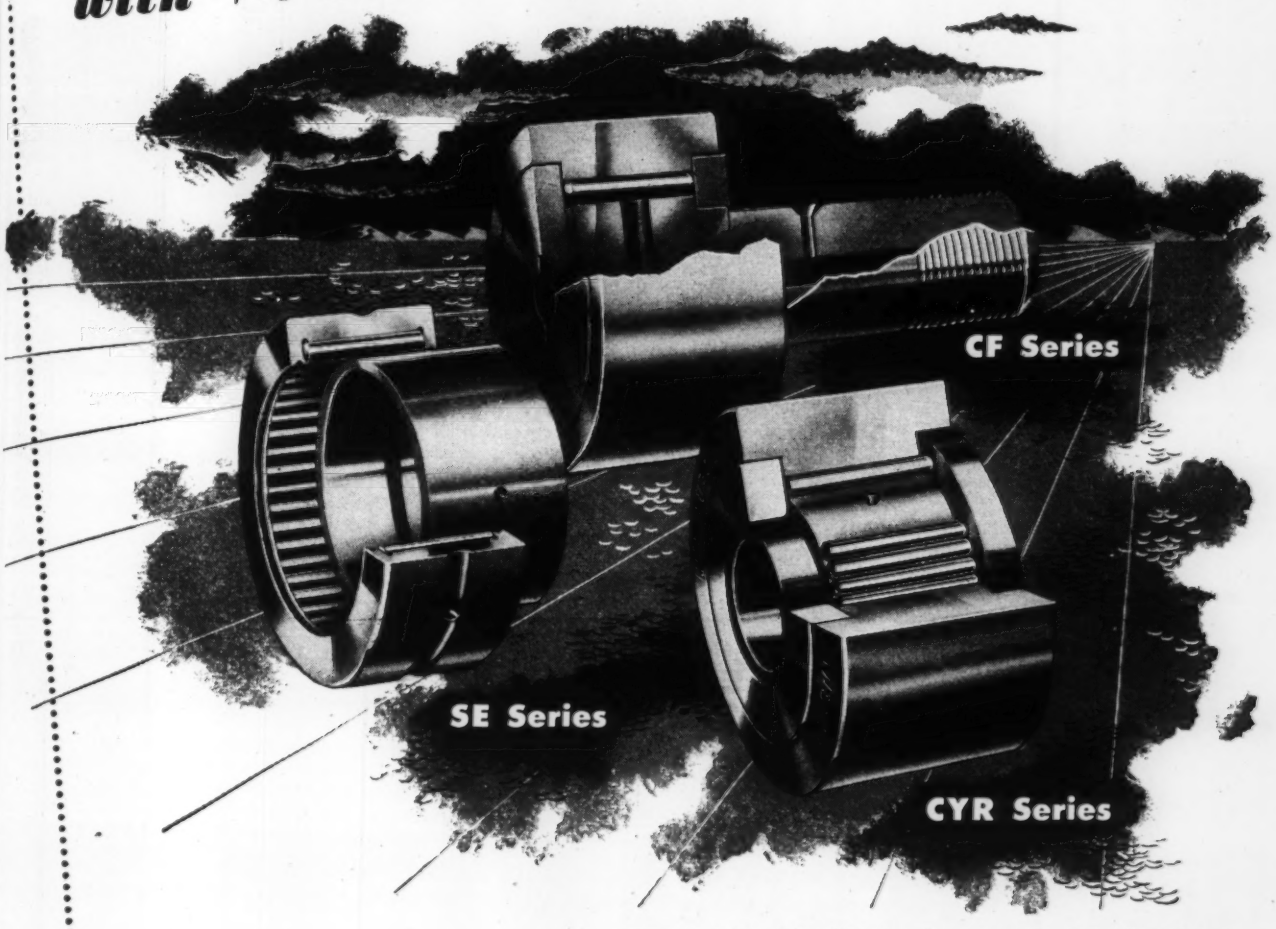
Design: Two identical hubs and a bolted floating sleeve engaged by gear teeth; parts machined forgings, Parco Lubrite processed for wear and corrosion resistance; lubricant holes in flange; lip type synthetic seals in large sizes, O-ring in small sizes; light press fit bores; crown flanked gear teeth to reduce backlash

Application: For connecting rotating shafts of machine drives.

For more data circle MD 9, Page 185

"longer life and greater efficiency"

with McGILL® MULTIROL® Bearings



Compared with friction hampered plain bearings McGILL MULTIROL full type roller bearings resist wear because of their easily lubricated roller line contact with raceways. Longer life and greater efficiency is the natural result of the constant precision maintained in the bearing. Lubrication is simplified and required much less frequently. Maintenance is free of costly down time for periodical adjustments and bearing replacement. MULTIROL bearings are your assurance of adding these advantages to the operation of your machinery. Millions in service to date prove such exclusive features as one piece outer race and roller retaining end shoulders and lubrication reservoirs above roller ends in the SE Series. CF and CYR Series have thick outer race sections for heavy shock load in cam action applications. Mounting is possible with or without stud. Write today for Bulletins on all MULTIROL Bearing series.

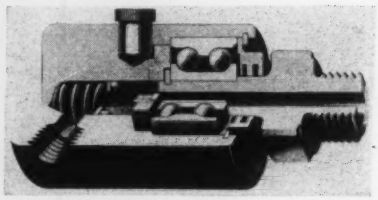
McGILL® precision bearings

McGILL MANUFACTURING CO., INC.
BEARING DIVISION, 200 N. LAFAYETTE ST.
VALPARAISO, INDIANA

NEW PARTS AND MATERIALS

Rotary Joint 10

Fawick Airflex Co. Inc., 9919 *Clinton Rd., Cleveland* 11, *Ohio*



Style: Single or multiple passage; rotary; self-contained

Size: ¼ to 1½ in. pipe thread (single passage), ¼ and ½ in. pipe thread (multiple passage)

Service: Air, liquids or gases; vacuum to 150 psi max pressure; multiple-passage permits handling several different mediums simultaneously; speeds to 2500 rpm, continuous or intermittent

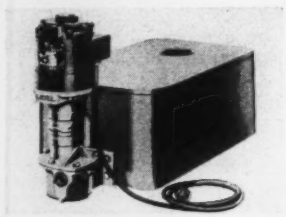
Design: Male screw connects to drilled and tapped hole on rotating shaft; nonmetallic spring loaded sealing ring; unrestricted rotation

Application: For transmitting fluids from stationary to rotating machine members.

For more data circle MD 10, Page 185

Coolant System 11

Power Tool Div., Rockwell Mfg. Co., Milwaukee 1, *Wis.*



Style: Motor driven centrifugal pump flange mounted to tank; portable

Size: Pump and motor, 21⅞ in. high; 16-gal tank; ¼-hp motor; ¾ and 1-in. discharge pipe; system weight, 65 lb.

Service: One unit can supply eight drill spindles; coolant flow with 1725 rpm motor and 70F temp (water and sal soda solution) at 0 head 20 gpm (¾-in. pipe), 32 gpm (1-in. pipe); at 5 ft head 14 gpm (¾-in.), 27 gpm (1 in.) at 10 ft head 7 gpm (¾-in.), 17 gpm (1 in.) max lift with water 14 ft.; motor—115/230v 60 cycle 1725 rpm; 115/230v 60 cycle 1425 rpm, or 220/440v 50/60 cycle 1425/1725 rpm

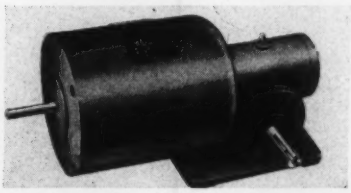
Design: Feed adjustable from full flow to shut off; motor totally enclosed; assembly includes nozzle, valve, column mounting clamps, and flexible hose; ball bearings double sealed lifetime lubricated; settling basin with filter screen.

Application: For supplying coolant to machine tools.

For more data circle MD 11, Page 185

Miniature Gearmotor 12

United Electric Machinery Co., 1824 *N. 72nd Court, Elmwood Park, Ill.*



Style: Single reduction, right angle; foot-mounted or vertical ring flange type

Size: 1/30 to ⅛ hp; 4⅝-in. O. D. motor

Service: Heavy duty; gear ratio to 60:1; 1725 or 3450 rpm, a-c for any voltage, frequency or phase

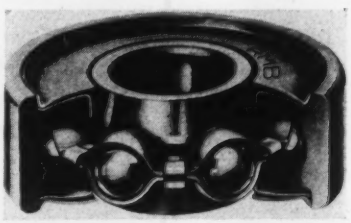
Design: Die cast aluminum rotors with integral fan; die cast aluminum end bells with steel bearing inserts; four ball bearings in gear case splash lubricated, front motor ball bearing permanent seal prelubricated; gear case shaft seals neoprene; double and high-speed take-off shafts special

Application: For reduced speed drive in machines.

For more data circle MD 12, Page 185

Antifriction Bearing 13

Landis & Gyr Inc., 104 *Fifth Ave., New York* 11, *N. Y.*



Style: RF series sealed, precision ball

Size: Bore sizes from 3mm to 8 mm (0.1181 to 0.3150-in.) with outside diameters 10mm to 22mm (0.3934 to 0.8661-in.) respectively

Service: Speed and load ratings same as for open bearings of corresponding size, *e.g.*, RF-416 carries 14.4 lb. for 5000 hours at 1000 rpm

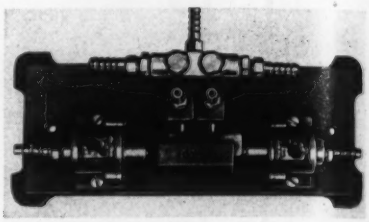
Design: No contact capillary seals; capillary chamber formed by cylindrical extruded section of inner cover and tapered section of inner race; rotation characteristics of open bearing; external bearing surfaces can be chrome plated for corrosion-resistant applications

Application: For antifriction mounting of rotating shafts of machine drives under conditions requiring low internal friction and/or corrosion resistance.

For more data circle MD 13, Page 185

Pneumatic Timer 14

Mead Specialties Co., 4114 *N. Knox Ave., Chicago* 41, *Ill.*



Style: Model 4, remote reverse valve

Size: Base 10¼ x 4¼ x 2¾ in. high overall

Service: Standard shop air pressures; continuous cycle

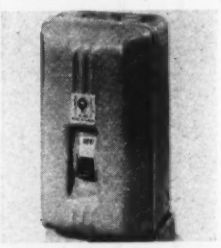
Design: 5-way plunger-operated control valve cam actuated by remotely controlled air pistons; an FC-1 limit valve is tripped by machine motion causing timer to shut off air from forward moving cylinder and admit air for return motion (single acting cylinders spring returned)

Applications: For controlling the sequence of operation of single or double-acting cylinders employed in machine drives.

For more data circle MD 14, Page 185

Motor Starter 15

Westinghouse Electric Corp., P. O. Box 2099, *Pittsburgh* 30, *Pa.*



Designation: Motor Watchman

Style: 3 enclosure types—standard sheet steel, watertight or explosionproof; flush panel mount, single or double-pedestal floor mount, safety lockoff, or external lockoff types

Size: 7½ hp polyphase, 5 hp single phase and 1½ hp d-c

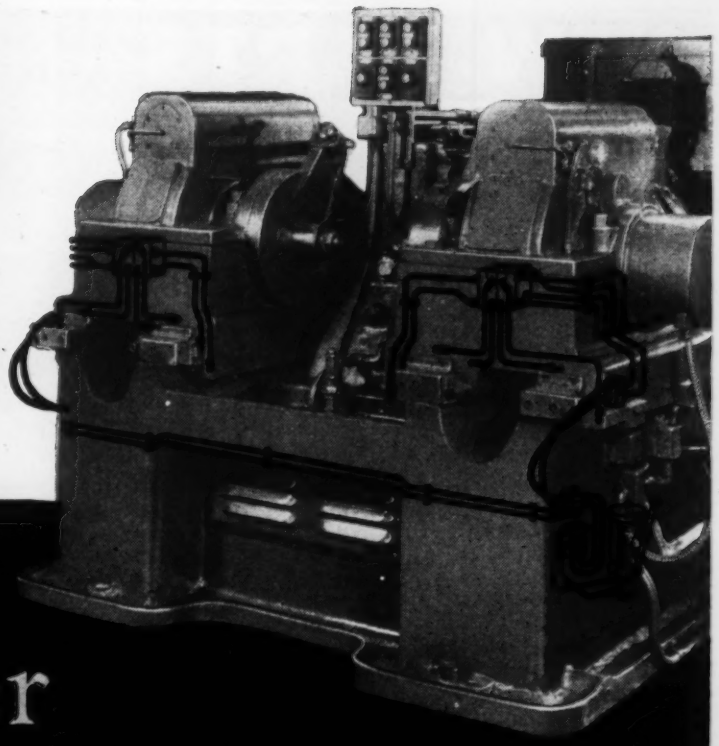
Service: 600v a-c, 220v d-c; class 10-100 reversing, class 10-130 2-speed 2-winding motor

Design: Quick-make, quick break, over-center toggle; De-ion arc quenching; bimetallic disk type thermal overload relay; straight through wiring; Bonderized enclosures; self indicating handle prevents opening while on; safety latch keeps switch off for servicing

Application: For starting, stopping, reversing and overload protection of single phase, polyphase and d-c motors.

For more data circle MD 15, Page 185

How You Can Design More Production into Your Machines!



ALEMITE
REG. U. S. PAT. OFF.

Accumeter
automatic lubrication
reduces maintenance, increases machine output

You eliminate shutdown for lubrication, thus adding production time to machines . . . when you *design in* Alemite Accumeter Automatic Lubrication. An Accumeter System consists of a lubricant pump, a distribution system of copper tubing, and *force-feed* valves for individual bearings. It lubricates all the bearings on a machine from one central point . . . automatically . . . while production goes on uninterrupted! Ends the risks of lubrication errors or neglect by your customers. Makes your machines produce more . . . cost less to operate . . . last longer!

Alemite Accumeter Systems meter oil or grease to bearings with a degree of accuracy never before achieved. In fact, tests show *no variation* in the amount of lubricant discharged . . . even after 73,312 lubrication cycles, the equivalent of 122 years of twice-a-day service! Furthermore, lubrication is either fully hydraulic or continuous between cycles, thanks to an exclusive "accumulating" feature in the Accumeter valves that *prolongs* the discharge of lubricant to bearings!

Versatile in application, Alemite Accumeter Automatic Lubrication Systems are adaptable to virtually any machine. There are three types, to cover your full range of requirements. Send now for free bulletin giving full data. Write to Alemite, Dept. R-31, 1850 Diversey Pkwy., Chicago 14, Illinois.

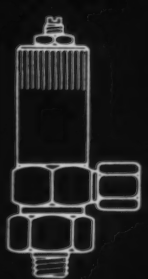
MIDGET OIL VALVES
Fixed output metering valves for single line system. Serves up to 200 small bearings—especially on precision machines or where space is limited.

1-BEARING VALVES
Oil or grease metering valves, with *fixed or adjustable* output, for single line system. Valves for any bearing capacity. Single system serves up to 400 bearings.

2-BEARING VALVES
Adjustable output metering valves for oil or grease. Each serves 2 bearings. Valves fully sealed, hydraulically operated on both load and discharge cycles. System handles up to 600 bearings. Manual or automatic operation.

TYPE 0

TYPE I



TYPE II

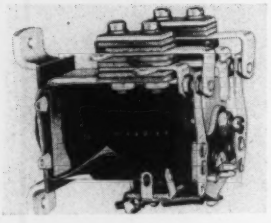
ALEMITE
REG. U. S. PAT. OFF.
1850 Diversey Parkway, Chicago 14, Illinois

Another Product of STEWART WARNER

NEW PARTS AND MATERIALS

Electronic Control 16

Potter & Brumfield, Princeton, Ind.



Style: LM series; SPST, DPST (NO or NC) and SPDT, DPDT

Size: SP—2¼ x 1⅜ x 2⅜ in. high; DP—2¼ x 2⅛ x 2⅜ in. high

Service: 2500, 5000 and 10,000-ohm coil resistances; normal operating power 0.015w (SP), 0.070 w (DP)

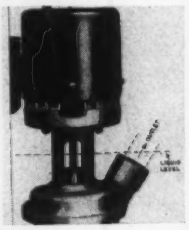
Design: Open construction; high sensitivity; adjustable armature return spring, adjustable residual screw for controlling ratio between pull-in and drop-out current; 3/16-in. silver contacts

Application: For packaging, counting, smoke control, and other electronic control circuits.

For more data circle MD 16, Page 185

Multipurpose Pump 18

Taco Heaters Inc., 137 South St., Providence 3, R. I.



Style: Centrifugal pump-motor unit; bracket mounted

Size: 1/25-hp motor; 1-in. inlet, ¾ in. NPT outlet

Service: Water, refrigerants, soluble oils, coolant; 10 gpm against 3-ft. head

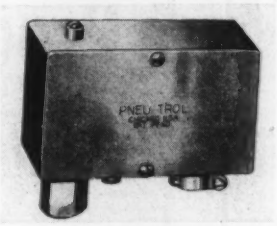
Design: Bronze body, bracket and impeller; stainless steel shaft; filter screen at intake; self-lubricating; packless; lightweight

Application: For circulating liquids in refrigeration, coolant, water cooling and similar systems where pressure is not required.

For more data circle MD 18, Page 185

Time-Delay Switch 20

Pneu-trol Devices Inc., 1436 N. Keating, Chicago, Ill.



Style: Adjustable, automatic reset

Size: 3⅞ x 2⅜ x 1⅜ in. overall

Service: Time dwell ¼ to 10 seconds

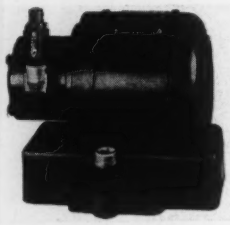
Design: Knurled adjustment screw moves switch position in relation to piston lever arm for desired time delay; may be mounted near mechanical stop

Application: For electric solenoid valve controls used with pneumatic or hydraulic cylinders in processing machines where operation time must be regulated.

For more data circle MD 20, Page 185

Dry-Air Compressor 17

Romec Div., Lear Inc., Elyria, O.



Style: Model RG-8160-1, compressor-motor unit

Size: Overall height 5 9/16 in., overall length 5 37/64 in.; weight 5.1 lb; inlet port ⅛-in. ANPT female, outlet port ⅛-in. ANPT male on check valve; motor 1/5 hp, 7200 rpm

Service: Duty cycle 15 minutes of every hour, occasional 30-minute periods possible; 1000 hour normal life; temperature range +160 to −85F; maintains sea-level pressure to 50,000 ft; rated at more than 1000 cim at sea-level, 80 cim at 3.4 in. Hg abs. against back pressure of 32 in. Hg abs.; input voltage 115v a-c, single phase, 400 cps; input current 3.5 amps at sea level, 6 amps max at −85F for starting

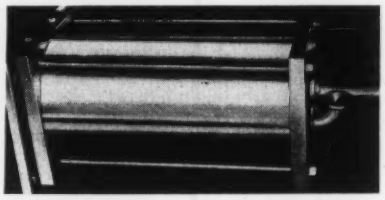
Design: Positive displacement pump, Graphitar blades; self-lubricating; pump-and-motor shaft on prelubricated ball bearings

Application: For supplying oil-free compressed air to electronic units in high-altitude aircraft.

For more data circle MD 17, Page 185

Pneumatic Cylinder 19

Miller Motor Co., Chicago 18, Ill.



Style: Model C, counterbalance type, single or double-acting; flush end, angle bracket, trunnions, or extended tie-rod mounts

Size: Bores 8, 10, 12, 14, 16, 18, and 20-inch; piston rod 1⅜-12, 1¾-12, 2-12, 2½-12, 3-12, and 3-12 thread, respectively; pipe connection 1¼, 1½, 2, 2½, 2½, 3 and 3 in.

Service: Air pressure 200 psi; stroke to suit; 20-in. cylinder produces 30-ton lift at rated 200 psi

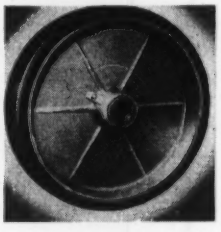
Design: Breather and pipe elbow interchangeable for cap end or rod end air supply; double-acting cylinders with pipe elbows both ends; ball check or standard breather; steel heads, caps and mountings; chrome plated piston rods; leakproof, self-regulating seals; brass honed barrels

Application: For machines such as presses requiring high-power lifts.

For more data circle MD 19, Page 185

Industrial Wheel 21

Aerol Co. Inc., 2820 Ontario St., Burbank, Calif.



Style: Free wheel, solid rubber thread

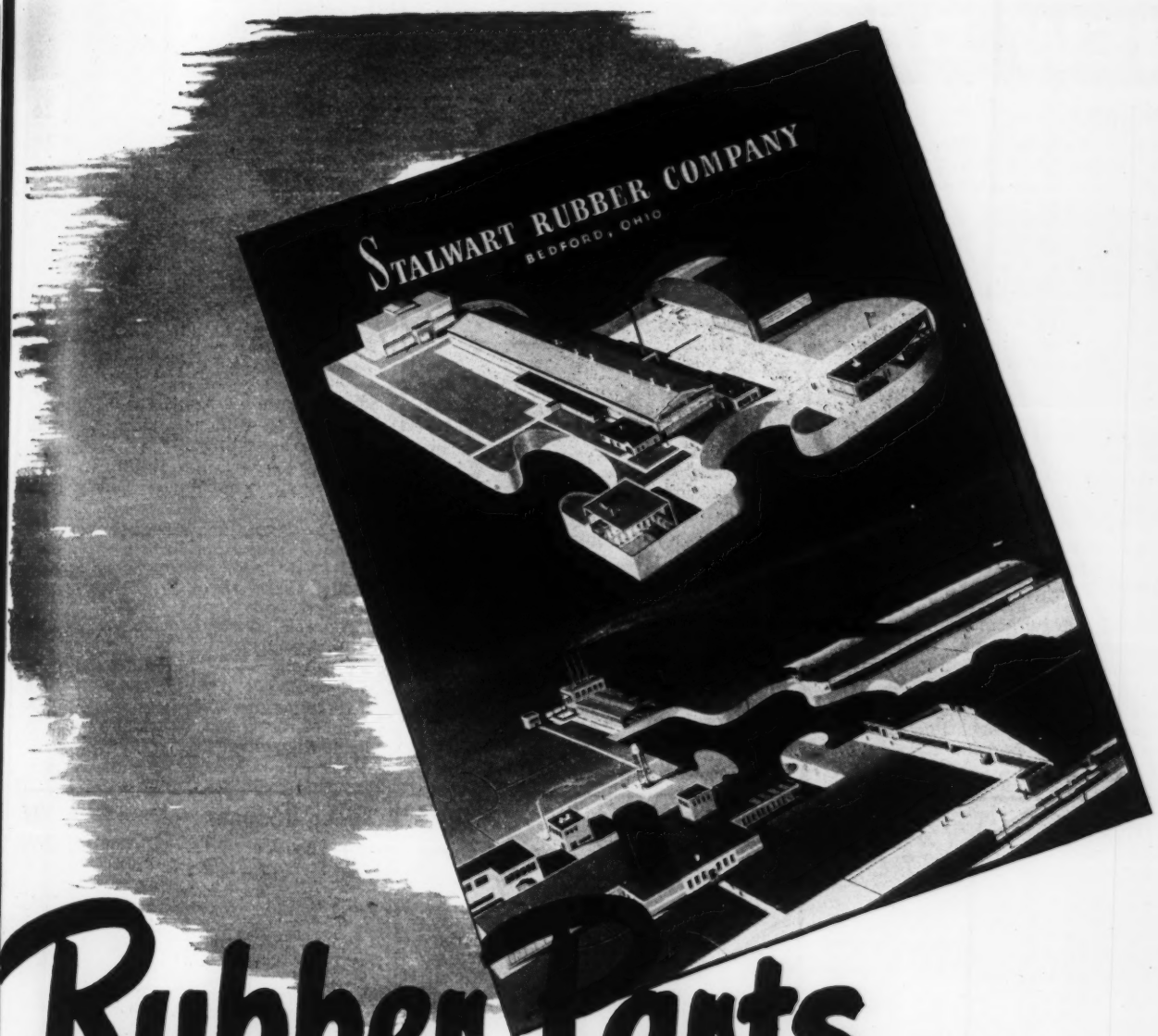
Size: Wheel diameter 6, 8, 10, 12, 14 and 20 in.; tread width 1½, 1 13/16, 2¼, 2¾, 2 1/16, 3 3/16 in. respectively; weight 3¼, 4¼, 5¼ and 5½, 7, 12, and 19¼ lb. respectively; axle bore ½, ⅝, ¾, ⅞, and 1 x 2⅛ in. (6-in.) x 2⅝ (8 in.), ¾, ⅞, 1, 1⅛, and 1¼ x 3⅛ in. (10 and 12 in.) 1⅛ and 1¼ x 3⅝ in. (14 and 20 in.)

Service: Load ratings at 3 mph 240-275 lb. (6-in.), 300-350, (8-in.) 450-600 (10 in.), 550-700 (12 in.), 850 (14-in.) and 1000 lb. (20 in.)

Design: Permanent mold aluminum alloy castings, rubber tread, unhardened straight-rolled bearings for cold-rolled axles; zerk lubrication fitting; flush lip seals staked in; hardened roller bearings to carry heavier loads, special

Application: For rolling equipment used in shops, foundries, mills, meatpacking and other industrial plants.

For more data circle MD 21, Page 185



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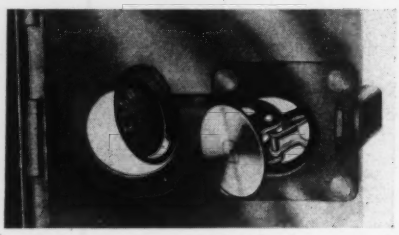
NEW PARTS AND MATERIAL

Flush Latch 22

Aircraft Hardware Div., Modern Metal Spinning & Mfg. Co., 2812 So. Main St., Los Angeles, Calif.



Style: Over-center toggle type

Size: 3⅛ in. × 1⅜ in. wide, 0.718 max depth; weight, 1 oz.

Service: Splashproof and moisture-resistant door or panel latching

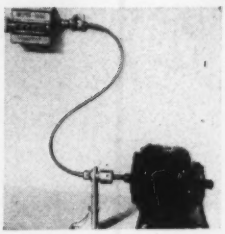
Design: Flush surface; stainless steel construction; latch openings rubber gasketed; finger-tip pressure opens, structural damage occurs before accidental release; accommodates door thicknesses from 0.040 to 0.125-in. and doublers from 0.051 to 0.150-in.

Applications: For quick open and close lock on inspection and access doors or panels.

For more data circle MD 22, Page 185

High-Speed Counter 24

Production Instrument Co., 702-08 W. Jackson Blvd., Chicago 6, Ill.



Style: Mechanical, flexible shaft drive; 5 or 7 digits; manual reset

Size: 4 15/16 x 3 15/16 x 2⅜ in. overall; flexible shafts 12, 24 or 36 in. long

Service: To 4000 counts per minute

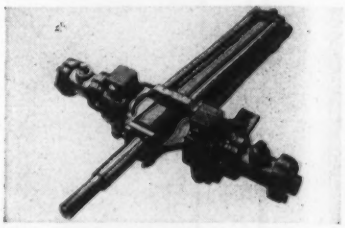
Design: Top coming or top going shaft rotation, right or left shaft extension; counter and drive shaft adaptors and brackets; all steel housing; plastic window; large counter shaft with oversize bearings

Application: For counting and registering revolutions per minute of rotating elements in machines.

For more data circle MD 24, Page 185

Hydraulic Cylinder 26

Benjamin Lassman & Son, Pittsburgh 22, Pa.



Style: Trunnion type, rigid piping

Size: ¾ to 2-in. pipe; bores to 12 in.; strokes to suit

Service: Hydraulic fluids to 3500 psi max; continuous heavy duty oscillation

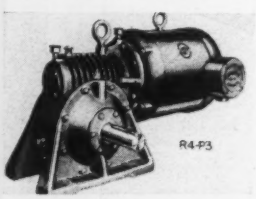
Design: Trunnions integral cast with heads; trunnions have hydraulically balanced swivel connections, any angle through 360; cylinder bored and honed forging, piston rod forged steel, other parts cast steel and bronze

Application: For machines requiring high-power oscillating strokes, in installations where hose connections between cylinder and hydraulic source are undesirable.

For more data circle MD 26, Page 185

Gearmotor 23

Janette Mfg. Co., Chicago 6, Ill.



Style: R4P; open ventilated, overhung; foot or flange mounted

Size: ¾ through 7½ hp

Service: 1140 rpm (single phase ¾ through 1 hp), 1140/1725 rpm (polyphase or d-c through 7½ hp); output rpm—4.65 and 3.46 (¾ hp, 1140 rpm)—8.8, 7.24, 6.15, 5.25, 4.65 and 3.46 (1, 1140)—30.0, 25.0, 16.2, 13.3, 11.0, 9.3, 7.95, 7.04, and 5.24 (1½, 1725)—20.0, 16.3, 10.7, 8.8, 7.24, 6.15, 5.25, 4.65, and 3.46 (1½, 1140)—99, 76, 58, 47, 41, 30, 25, 16.2, 13.3, 11.0, 9.3 and 7.95 (2, 1725)—7.24 and 6.15 (2, 1140)—99, 76, 58, 47, 41, 30, 25, 16.2, 13 and 11 (3, 1725)—20, 16.3, 10.7, and 8.8 (3, 1140)—99, 76, 58, 47, 41, 30, 25, and 16.2 (5, 1725)—27, 20 and 16.3, (5, 1140)—99, 76, 58, 47, and 41 (7½, 1725)—65, 50, 38, 31, and 27 (7½, 1140)

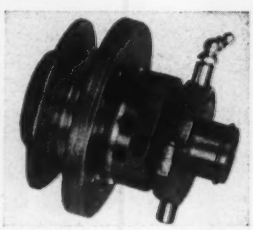
Design: Integral construction, gear boxes include single or double reduction, worm gear or combination worm-and-planetary gears

Application: For speed reduction in horizontal or vertical drives.

For more data circle MD 23, Page 185

Friction Clutch 25

Edgemont Machine Co., 2200 Home Ave., Dayton 1, Ohio



Style: Type K, friction disk, manual shift

Size: Shafts ⅝, ¾ or 1 in.; pulley OD 3⅜ or 3¾ in.

Service: Stub or through shaft; hp per 100 rpm 0.3 or 0.4

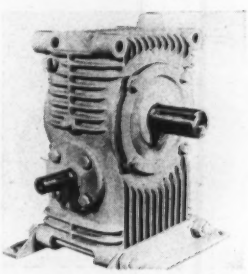
Design: Integral pulley, one or two groove; positive lock in engaged position, will not disengage at increased speeds; threaded steel adjuster clamped at desired point for settings of max pull with min engage pressure; bronze shifter ring, Oilite bronze bearings, all other metal parts steel or cast iron; available for use with plate sprocket for short idling periods (K-S) and cutout coupling for control of two aligned shafts or extended sleeves for mounting sprockets, gears, etc., in through shafts (K-E)

Application: For power transmission from gasoline engines, electric motors and speed reducers on stub shafts or machine drives with through-shafts.

For more data circle MD 25, Page 185

Speed Reducer 27

Cone-Drives, Div. Michigan Tool Co., Detroit 12, Mich.



Style: Right-angle, models S-7200 and S-72500

Size: Center distances, S-7200, 2 in. and S-72500, 2½ in.; S-7200—$9\frac{3}{16}$ in. high including breather and base, $8\frac{53}{64}$ in. long including breather and shaft and $7\frac{5}{16}$ in. wide including shaft and base, weight 25 lb.; S-72500—11¾ x $9\frac{11}{16}$ x 8⅛ in., 43 lb.

Service: Class I; ratios for both models 5, 10, 15, 20, 25, 30, 40, and 50:1; hp ratings at 1750 rpm for respective ratios 2.96, 1.95, 1.40, 1.10, 0.86, 0.73, 0.55, and 0.45 (S-7200) and 5.52, 3.64, 2.66, 2.02, 1.63, 1.36, 1.03, 0.83 (S-72500)

Design: Mounting brackets can be shifted to change relative position of pinion and gear shafts; high-carbon alloy-steel pinion, chill-cast tin bronze double-enveloping gears, ball and roller bearings; splash lubrication

Application: For reducing medium-duty right-angle drives.

For more data circle MD 27, Page 185

Induction Motor 28

Electric Machinery Mfg. Co., Minneapolis, Minn.

Style: Wound rotor, open or drip-proof, forced ventilation

Size: 30 to 1500 hp; width 32¾ to 51½-in., height (excluding eyes) 28⅞ to 45⅝ in., length (including shaft) 46⅝ to 70¼ in.

Service: 450 to 1800 rpm; 208 to 2300 v, 2 or 3-phase, 50 or 60 cycles

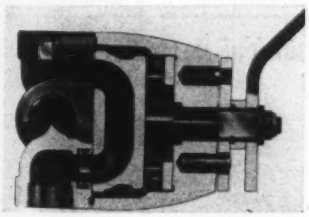
Design: Steel frame; ball or split sleeve bearings; superfinished journals on sleeve type; brush pressure adjusted with ratchet wheel adjuster

Application: For variable-speed machine drives requiring high starting torque low starting current or long acceleration periods.

For more data circle MD 28, Page 185

Fluid Valve 29

Barksdale Valves, 1566 E. Slauson Ave., Los Angeles, Calif.



Style: Shut-off, 4-way selector, 4-way dual pressure, or manipulator; table, bracket or panel mounted

Size: Shut-off and selector ¼ to 1½ in. pipe ports; manipulator ⅜ to 1 in. pipe ports

Service: Water, air, hydraulic oil, gas, fuel, and petroleum; shut-off and selector 0 to 6000 psi max; dual pressure 3000 psi max or 6000 psi max; manipulator 0 to 1500 psi max

Design: Pressure balanced, self-aligning, tubular valve seat in close contact with optically flat porting disk, rotary motion of disk opens and closes flow passages; wave springwasher maintains seal under no flow; bodies high tensile bronze with in-line, straight or manifold porting; housings Meehanite; rotors hardened corrosion-resistant steel 4-way valves open or closed center

Application: For control of fluid feed, power or control systems in machines.

For more data circle MD 29, Page 185

Now Available

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Now we can proudly refer American industry to this goodly list of electrical manufacturers, all able and willing to supply electric machines protected by Class H insulation made with Dow Corning Silicones.

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KURZ & ROOT COMPANY
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THE MASTER ELECTRIC COMPANY

* "Class H" insulation is the kind of insulation that keeps motors running in spite of "Hell and High water." (*slanguage dictionary*)

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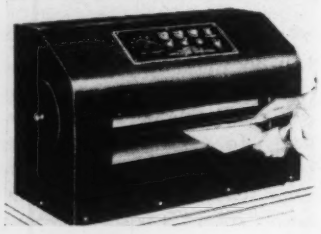
ENGINEERING DEPARTMENT

EQUIPMENT

For additional information on this new equipment, see Page 185

Photocopy Machine 30

American Photocopy Equipment Co., 2849 N. Clark St., Chicago 14, Ill.



Style: CP-18, automatic

Size: 24 x 15 x 20-in. high

Service: Continuous, direct photocopy of colored, written, printed, typed, drawn, or photographed copy; 400 8½ x 11 in. copies per hour; copies up to 18 in. wide and any length

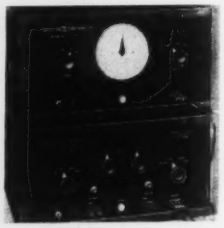
Design: Automatic feed mechanism; control panel or copy quality

Application: For making permanent copies of engineering drawings, blueprints, etc.

For more data circle MD 30, Page 185

Chronoscope 31

American Chronoscope Corp., 316 West First St., Mt. Vernon, N. Y.



Style: Model 110 electronic chronoscope and model 211 input adapter

Size: Individual units 19½ x 13¾ x 9¾ in. high; standard 19 in. mounting panels

Service: 8 scales for 0-1, 0-3, 0-10, 0-30, 0-100, and 0-300 milleseconds and 0-1, 0-3 seconds duration; open circuit, short circuit or voltage pulse of 6v or more; both units operate on 110/120v 60 cycle

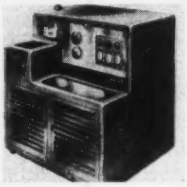
Design: Accuracy ±1% over full scale any range; self-balancing potentiometer transmits percentage loss of charged capacitor across resistor to mechanical pointer on clock dial; adapter separates function of starting and stopping the measurement intervals without stopping system or synchronizing indicating device

Application: For measuring the time intervals of electric circuit operations.

For more data circle MD 31, Page 185

Hot-Cold Tester 32

George L. Nankervis Co., 19255 W. Davison, Detroit 23, Mich.



Style: Thermal deep well

Size: 30 x 40 x 54 in. overall; accommodates parts to 6 x 6 x 8 in.

Service: Hot-cold test simulating actual service conditions; produces temperatures from −70 to +230F; metho-ethanol refrigerant; electric power and cooling water from outside conductors

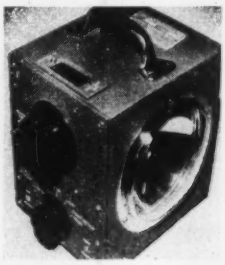
Design: Thermal selector for desired temperature, totally enclosed motor, automatic relief valves, explosionproof electric components

Application: For testing aircraft and industrial components.

For more data circle MD 32, Page 185

Strobotac 33

Electronic Measurements Co., Red Bank, N. J.



Style: Model 351A, stroboscopic tachometer

Size: 7½ x 8¾ x 9⅞ in. overall, 9½ lb

Service: 600 to 14,400 flashes per minute; multiples of flashing speed give measure to 100,000 rpm; multiple images used for speed below 600 rpm; operates on 105 to 125v 50/60 cycles, consumes 35w

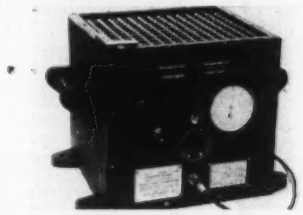
Design: Accuracy ±1% of dial reading above 900 rpm when unit is standardized in terms of a frequency controlled power line, controls for adjustment provided; external flashing accuracy that of flash source; no physical connection with rotating equipment

Application: For measuring speed of rotating equipment without physical connection.

For more data circle MD 33, Page 185

Dynamometer 34

Avion Instrument Corp., 121 E. 24th St., New York 10, N. Y.



Style: Direct reading, magnetic particle coupling, portable

Size: 11 x 11 x 12 in., 130 lb.

Service: Measures torque of motors from ½ to 10 hp; operating speeds, 0 to 6000 rpm; max operating temp (without external cooling) 220 C; excitation 28 v d-c

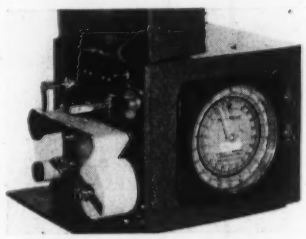
Design: Accuracy 5% at full load; panel dials indicate speed and torque, calibrated from 1500 to 6000 rpm; rheostat for adjusting excitation voltage; flexible shaft coupling for low-speed loads

Applications: For measuring torque.

For more data circle MD 34, Page 185

Mechanical Recorder 35

Streeter-Amet Co., Chicago 13, Ill.



Style: Model SCI (9 models with timer, 2 without); type A counts continuously, type B does not count during print and reset; manual or automatic reset

Size: 9½ x 11¾ x 14 in., 44 lb.

Service: Timing or counting data; heavy-duty; print periods 1/60, ¼ and 1 hr. (Telechron timer) or variable from 1/3 to 2 hr (repeat cycle timer); 110v 60 cycle or 6-v battery

Design: Actuated by electric pulse or signal from contact switch, metal detector, photo tube and amplifier, etc.; large reading dial; housing heavy sheet steel; parts heavy plated against corrosion

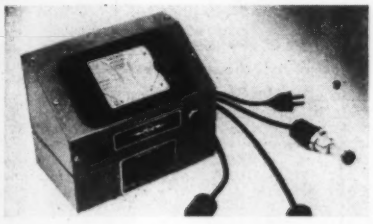
Application: For recording time and count data and also changes in electrical intensity, time intervals of operations, etc., or in conjunction with installations for counting units of repetitive processes.

For more data circle MD 35, Page 185

EQUIPMENT

Vacuum Gage 36

Hastings Instrument Co., Hampton, Va.



Style: Electrical, metal thermopile

Size: 7½ w x 4½ d x 6½ in. high; ⅛-in. male pipe connector

Service: Continuous measure of absolute pressures from 0 to 1000 microns of mercury

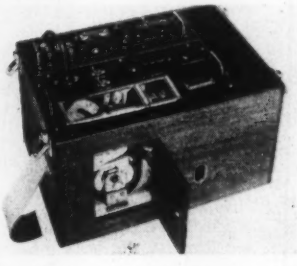
Design: Noble metal thermopiles and nickel-plated pickup tubes; five-position switching permits five stations per standard selector unit to be connected to each indicator

Applications: For measuring vacuum and detecting leaks.

For more data circle MD 36, Page 185

Strain Recorder 37

Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.



Style: Strip-chart, direct-writing, inkless

Size: Case 17 x 11 23/32 x 9 7/16 in. overall; weight 32½ lb

Service: Amplifier a-c powered, input impedance 2000 ohms; with one SR-4 strain gage of factor 2, sensitivity 50 micro-inches/inch/cm defelection; deflection proportional to number of active arms, connections for 2 and 4-arm external gage circuits; standard paper speeds 25 mm max, variations available

Design: Heated stylus registers on heat-sensitive paper; strain gage amplifier of modulated carrier type with bridge excited at 2500 cps by built-in oscillator; D'Arsonval recording galvanometer

Application: For reproducing and recording strain gage measurements.

For more data circle MD 37, Page 185

GOT A RELAY PROBLEM?

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GENERAL PURPOSE RELAYS

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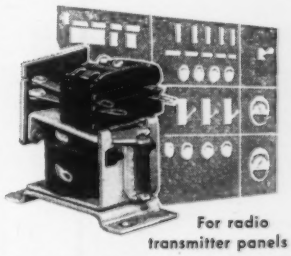
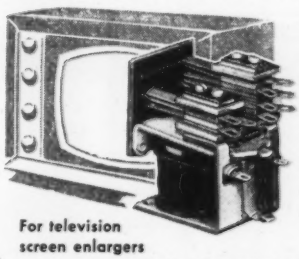
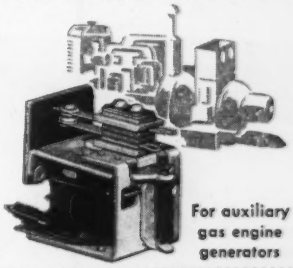


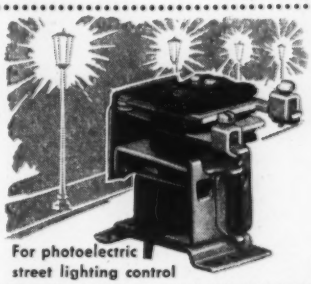
For radio transmitter panels



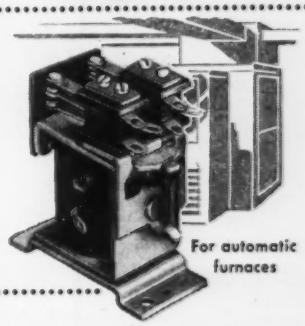
For television screen enlargers



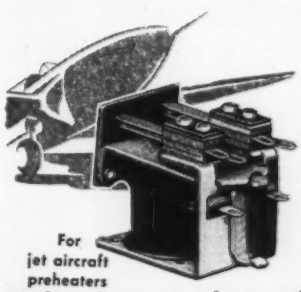
For auxiliary gas engine generators



For photoelectric street lighting control



For automatic furnaces



For jet aircraft preheaters

IN ADDITION R-B-M General Purpose Relays are used on X-Ray apparatus, permanent wave machines, wire recorders, automotive radio telephone communication equipment, vending machines, coin operated phonographs and many other applications.

What is your relay problem? Write Dept. B-3 today for Bulletin 570

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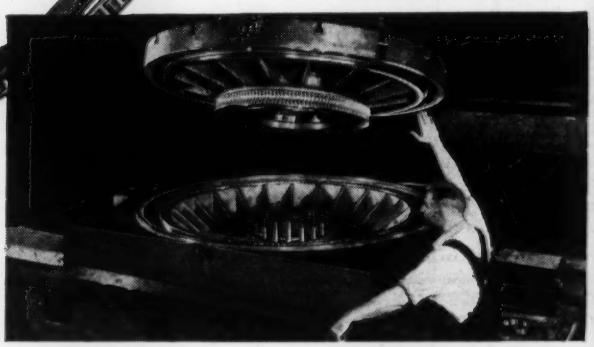
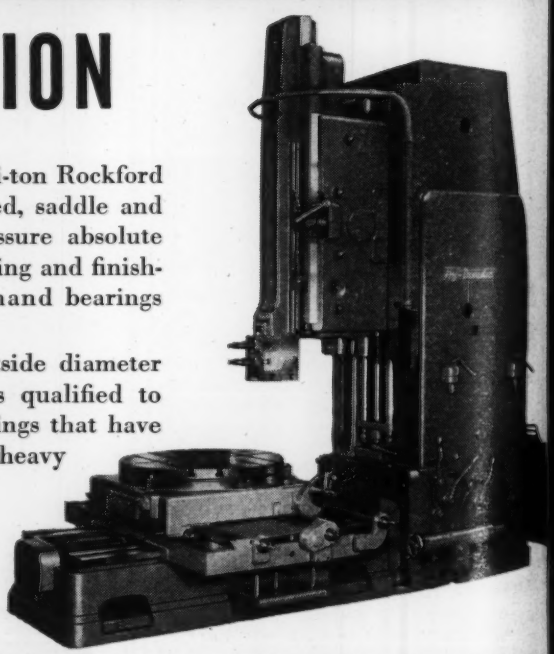
Big 70.500" x 74.000" x 3.000" KAYDON bearings aid smooth operation of the huge Rockford Hy-Draulic Slotter shown below.



Smooth OPERATION

Here was a challenge to precision bearings! Massive, multi-ton Rockford Hy-Draulic Slotters are high precision "all the way". Bed, saddle and slide of these precision machines are extra heavy, to assure absolute rigidity . . . the close tolerances maintained in the machining and finishing of all shafts, screws, gears and bearing surfaces demand bearings capable of heavy precision performance.

KAYDON met this challenge with big roller bearings (outside diameter exceeding 6 feet) . . . typical KAYDON precision bearings qualified to shoulder such responsibilities . . . the KAYDON kind of bearings that have helped many designers add greater productive utility to heavy stationary machinery and mobile equipment.



Whatever your bearing problem may be, contact KAYDON of Muskegon . . . you'll find all the facilities here for designing and producing bearings for specific duties.

KAYDON Types of Standard or Special Bearings: Spherical Roller • Taper Roller Ball Radial • Ball Thrust • Roller Radial • Roller Thrust • BI-ANGULAR Roller

THE KAYDON ENGINEERING CORP., MUSKEGON, MICH.

• ALL TYPES OF BALL AND ROLLER BEARINGS 4" BORE TO 120" OUTSIDE DIAMETER •

HELPFUL LITERATURE

FOR DESIGN EXECUTIVES

75. Carbide Tools & Parts

Carboloy Co.—60-page illustrated catalog GT-250 tells how to select and apply carbide tools and parts listed. Differences and limitations of various carbide grades are clarified. Nontool applications of carbide are covered also.

76. Maintenance Rubber Goods

Ohio Rubber Co.—8-page illustrated brochure outlines various facilities for supplying maintenance rubber goods, engineering and production services. Listed are such rubber and synthetic parts as molded, extruded and bonded types; flexible and hard plastics; and flexible decorative laminates.

77. Adhesives & Coatings

Minnesota Mining & Mfg. Co.—8-page illustrated handbook reports availability of 1000 different basic formulas, in addition providing technical data on 13 adhesives, 7 coatings and 7 sealers. Sixteen design problems and their solutions are pictured and described.

78. Aluminum-Coated Steel

Armco Steel Corp.—24-page illustrated booklet "Armco Aluminized Steel" describes the material's aluminum surface, its heat and corrosion resistance and heat reflectivity of 80 per cent up to 900° F. Included are a listing of applications, data on mechanical and forming properties, available sizes and gages and recomendations for welding, brazing and finishing.

79. Sealing Rings

Parker Appliance Co.—48-page illustrated O-ring catalog No. 903 lists dimensional and physical data for series of O-ring types including precision-molded industrial rings which meet JIC standards for air, water and hydraulic service; special formulations for use in sealing wide variety of specific liquids, gases and greases; and special grades molded to aircraft requirements.

80. Electric Counters

Production Instrument Co.—Illustrated bulletin has dimensional diagrams for standard and flush mounting and roll-back reset type small electric counters. Units are furnished for practically all alternating and direct current voltages.

81. Cut-out Couplings & Pulleys

Anchor Steel & Conveyor Co.—12-page illustrated catalog 50A describes line of cut-out couplings and pulleys that automatically shuts off motors when overloads occur. Resetting is also automatic. Formulas assist in determining size cut-out to use for specific applications.

82. Metal Stampings

Leake Stamping Co.—17-page illustrated bulletin "Steel Stampings" describes type of stampings produced, machinery used and supplementary facilities available. Various types and thicknesses of material can be stamped into large or small parts. Case histories cover welding, deep drawing, extrusion, brazing and cleaning operations.

83. Carrier Amplifier

Consolidated Engineering Corp.—4-page bulletin CEC-1522 describes type 1-118 instrument which simplifies analysis and evaluation of physical factors involved in successful product performance. When combined with a recording oscillograph, amplifier presents system of four channels for dynamic recording measurement.

84. Chains & Sprockets

Jeffrey Mfg. Co.—Illustrated catalog No. A418 covers complete line of chains and sprockets for both new and replacement service on elevating and conveying equipment. Listed and described are 22 types of malleable, steel and alloy chains as well as many types designed for special requirements.

85. Fluid Power Equipment

Oilgear Co. — 8-page illustrated bulletin 10051-A covers hydraulic pumps, motors, transmissions, cylinders and valves. Size, pressure ratings, speed and application information on each model are included. Cross-sectional drawings and detailed specifications are given.

86. How to Bend

O'Neill-Irwin Mfg. Co.—32-page illustrated manual "It's Easy To Bend with Di-Acro Precision Bending Machines" describes wide variety of bending operations performed on Di-Acro machines. Rotary type machines will bend round, flat, channel, angle and shaped material into squares, spirals, S-curves and other shapes. Tooling for each is pictured and described, along with the machines.

87. Diecastings

Hoover Co.—Illustrated boklet "Hints for Designing Good Die Castings" provides basic information and help to those who work with diecastings. It includes data on draft, tolerance, wall thickness and core size requirements as well as tables of chemical and physical specifications for alloys.

88. Automatic Valves

A. W. Cash Valve Mfg. Corp.—8-page illustrated bulletin 299 covers cross section of entire line of Cash-Acme valves for pressure relief or reduction and control of hot water heating systems. Types for handling various fluids and gases are described.

89. Gasoline Engines

Power Products Corp.—Illustrated catalog PP. W10 lists specifications of each of seven models of small gasoline engines. Details of vertical air-cooled model are included.

90. Bimetallic Thermostats

Stevens Mfg. Co.—2-page illustrated bulletin No. F-2008 describes type C bi-metal strip thermostats for use in communications equipent, electronic and avionic devices. Included are dimensions, schematic diagram showing operating principle and typical thermostat response curve.

91. Mill Motors

Westinghouse Electric Corp.—20-page illustrated booklet B-4730 describes 600-series mill motors and Class 9500 direct current magnetic mill auxiliary controllers. Controllers utilize type M contactor and are available in NEMA ratings from 25 to 2500 amp.

92. Lubrication Fittings

Universal Lubricating Systems Inc.—14-page illustrated 1951 industrial catalog lists hydraulic grease fittings, couplers, swivel couplers, control handle for boosting grease pressures to 12,000 psi and top oiler for upper cylinder lubrication.

93. Optical Comparators

Universal Engraving & Colorplate Co., Engineers Specialties Div. — 44-page illustrated catalog No. 9 lists standard and custom made charts, scales, rules and staging fixtures as well as accessories for use on all makes of optical comparators, measuring instruments and micro-projectors.

FOR MORE INFORMATION

on developments in "New Parts" and "Engineering Department" sections—or if "Helpful Literature" is desired—circle corresponding numbers on either card below

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94. Hydraulic Fluids

Union Carbide & Carbon Corp., Carbide & Carbon Chemical Div. — 12-page illustrated booklet "Uncon Hydrolubes" presents physical properties and application data on aqueous-base safety hydraulic fluids for aircraft and industrial use. Fire resistance, high viscosity index, low leakage loss and safety for workmen are cited.

95. Relays & Switches

Automatic Electric Co.—88-page illustrated catalog and technical guide "Relays and Switches for Industrial Control" details standard telephone-type relays, stepping switches and mounting facilities. Data are included for selection of components for any desired application, along with information on hermetic sealing for all relay types.

96. Electric Radiant Heater

Edwin L. Wiegand Co.—4-page illustrated mailing piece F1-523 depicts and describes Chromalox electric radiant heater for process heating applications. It employs new and improved infrared heating principle, all-metal construction, high heat intensity and variable output.

97. Electric Bushings

General Electric Co.—12-page illustrated bulletin GEC-715 discusses apparatus bushing standardization program which replaces more than 1000 different types of transformer and circuit breaker bushings with only 38 standard bushings. Types cover ratings from 15 to 230 kv, 1200 amp and below. Table lists replacements.

98. Rubber Parts Production

Stalwart Rubber Co. — 16-page illustrated catalog No. 51SR-1 lists facilities for custom fabrication of molded, extruded, lathe-cut and die-cut rubber parts which can be furnished to meet JAN or SAE specifications. Booklet lists by code number 30 compounds which are representative of more than 500 rubber stocks.

99. Ball Bearing Tables

Marlin-Rockwell Corp.—48-page bulletin No. 26 contains M-R-C ball bearing interchangeable tables and lists 12,500 ball bearings of various makes in numerical order and corresponding sizes of M-R-C replacements.

100. Seal & Washers

Design Aids Co.—6-page illustrated bulletin 1020 gives details of line of seals and washers applicable to bearings up to 4-in. shaft diameter. Seals are conventional in design and provide an inexpensive oil-tight dustproof enclosure.

101. Welding Electrodes

Jessop Steel Co.—8-page illustrated booklet "Jessop Stainless Steel Welding Electrodes" contains information on selection and application of stainless steel electrodes for welding stainless steel. Current range is furnished for each type of rod in varying diameters.

102. Stainless Pipe & Tubing

Babcock & Wilcox Tube Co.—4-page illustrated technical data card 140 charts condensed information on corrosion resistance, creep strength, oxidation resistance, mechanical properties, machinability, welding characteristics, heat treatment and physical properties of Croloy stainless pipe and tubing for pressure and mechanical uses.

103. Welding Alloys Chart

Eutectic Welding Alloys Corp.—6-page illustrated folder TIS 246 P can be filed, bound or unfolded to 11 x 23-in. chart for wall mounting. It contains specifications on approximately 100 different low temperature welding alloys used in welding, brazing and hard surfacing of steel, alloy steels, cast iron, brass, etc.

104. Conveyor & Elevator Belts

B. F. Goodrich Co.—26-page illustrated catalog section portrays belt features, explains why increased service life with decreased maintenance is made possible by construction and tells function which each part of belt performs. Described are cord, material, hot material, oil service, package, food handling, grain and special conveyor belts.

105. Anticorrosion Coating

Industrial Metal Protectives Inc.—8-page illustrated technical bulletin "Zincilate" presents case histories on typical applications of this one-coat self-protecting anticorrosion coating for ferrous metal. Methods of applying are shown, and properties of surface penetrating and nonpenetrating types are listed.

106. Custom Steel Parts

Henry Disston & Sons Inc.—20-page illustrated bulletin "Custom Steel Parts" deals with heat treated steel products which are made from flat steel and are hardened, tempered and machined. Produced to user's specifications, tools and replaceable steel parts can meet close tolerances, have shock or abrasion resistance and are made at low cost. Typical parts include pressure plates, cylinder jackets, straight edges, doctor blades, knives and feed strips.

107. Investment Castings

Austenal Laboratories Inc.—9-page folder "File on Microcasting Case Histories" describes precision investment casting applications. Each case cited includes a description of the part, where it is used and material from which it is made, along with savings and benefits derived from the process.

108. Variable Speed Drives

Reeves Pulley Co.—12-page illustrated bulletin G-509 contains rating tables and dimension drawings, plus operating principles of variable speed drives. Capacities range from ¼ to 87 hp with stepless speed changes within ratios from 2:1 to 16:1. Three basic units are included: Variable speed transmission, Vari-Speed Moto-Drive and Vari-Speed motor pulley, with manual and automatic controls for each.

109. Welded Steel Products

Cleveland Welding Co.—8-page illustrated catalog W-500 depicts and describes shapes of rings, bands, hoops, flanges and weldments manufactured. In addition, information is given on various metals handled by company and their specialization in such items as gear blanks; electrical motor shells; and truck, tractor and farm implement rims.

110. Coil Weight Calculator

Precision Steel Warehouse Inc.—Double dial-type calculator will compute weight and length of strip metals in coils or straight lengths. Designed for cold-rolled strip steel, instrument makes use of factor table for answers in aluminum, brass, copper, magnesium, Monel, zinc, etc.

111. Fastening Devices

Continental Screw Co.—100-page illustrated "1951 Catalog" lists head dimensions and other data on all types of slotted and Phillips recessed head screws. Included are thread dimensions, recommended uses, methods of applying, finishes, packaging and weights. Such special-purpose screws as Sems, Thredlock, Spin-Lock, Lock-Tite, Lubricized, Taped and ClutchHead screws are described.

112. Chain Drives

Atlas Chain & Mfg. Co.—Illustrated catalog ARC-51-PR is handbook for engineers and designers concerned with chain drives. Suggestions are given on how to install, maintain and operate roller chain units. Planning of chain drive layouts, lubrication and selection of roller chain for given applications are discussed. Included are length conversion, horsepower ratings and specifications.

113. Universal Indicator

Mogens Bang & Co.—6-page illustrated folder No. 525/E covers construction and application of Disa universal indicator. This instrument is an electronic device for measuring both static and rapidly alternating forces, pressures, distances and vibrations. Accessories such as pick-ups and synchro-marker are described.

114. Multiple-Part Diecastings

Gries Reproducer Corp.—1-page illustrated bulletin "Intercast" explains advantages obtainable by this method of producing multiple-part units having movable components. Such products as miniature scissors and interlinked chain are shown as examples of diecastings which are made to customer's specifications.

115. Liquid Level Gages

Bristol Co.—24-page illustrated bulletin No. L700 presents data on instruments for measuring and recording water depth. Float, pressure bulb, pressure, counterpoise, differential pressure and air-bubbler types of liquid level gages are described, as are units for measurement and automatic control of water and other liquids and solutions.

116. Small Tubing

Superior Tube Co.—4-page illustrated bulletin 32 on small tubing gives analyses, standard production limits, commercial tolerances, tempers and ordering information on seamless and welded and drawn types. Small tubing is available in all analyses in 0.01-in. to ⅝-in. OD and in certain analyses up to 1⅝-in. OD.

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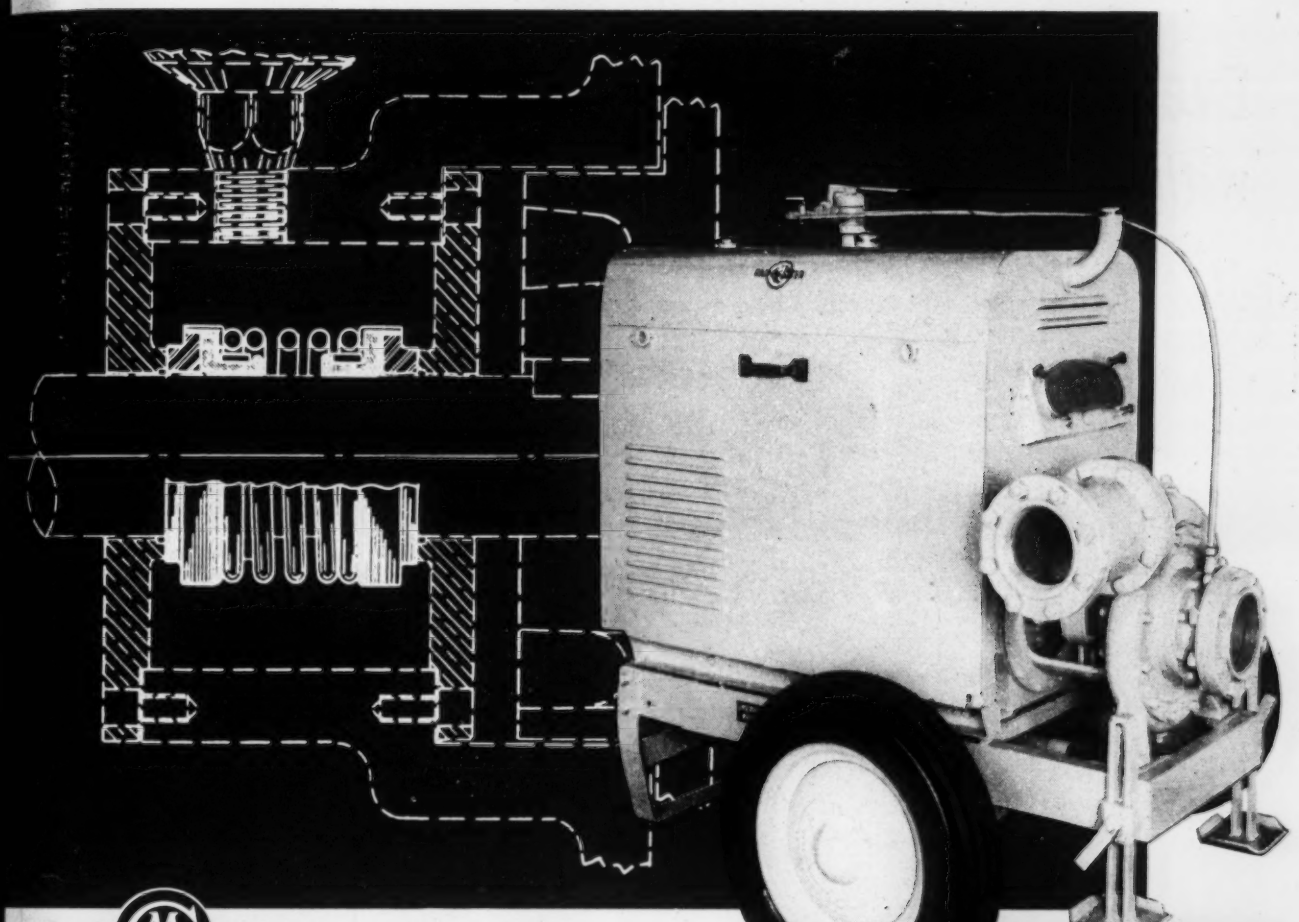

RAINMASTER Pumps get *Shaft-Sealing Certainty* with ROTARY SEALS

Here's a quote from the information sheet Construction Machinery Co., of Waterloo, Iowa, gives distributors and salesmen for its centrifugal pumps, which provide farmers with "mechanical rain" under all kinds of conditions:

"To eliminate the many difficulties inherent in stuffing box construction, the mechanical type Rotary Shaft Seal . . was developed . . CMC's proven solution to this problem is a self-adjusting Rotary Shaft Seal . . it is apparent that the CMC RAINMASTER Pump Seal provides the following advantages:

1) Eliminates Packing and Stuffing Box.
2) Prevents Gouging of Pump Shaft.
3) Effectively Seals Liquid in Pump.
4) Prevents Entrance of Air into Pump.
5) Prevents Contact of Abrasive Material with Seal.
6) Self-adjusting, Requiring only Occasional Lubrication."

CMC uses ROTARY SEALS for Shaft Sealing throughout its broad line.

Rotary Seal engineers, who have found practical solutions to Shaft Sealing problems like CMC's and many more in Pumps and other equipment of all kinds, can help *you* achieve *Sealing with Certainty* for your application, whatever your field. For best results, we suggest calling us in at the drawing board stage — our experience often indicates simpler and more efficient approaches to the Sealing problem which greatly facilitate successful design.

THE ROTARY SEAL PRINCIPLE

is the original approach to a practical solution of a universally troublesome problem. Our booklet "SEALING WITH CERTAINTY" explains and illustrates the principle. We're glad to send it to you without obligation.

THE mechanical seals for ROTARY SEAL COMPANY rotating shafts

[illegible] NORTH LaSALLE STREET
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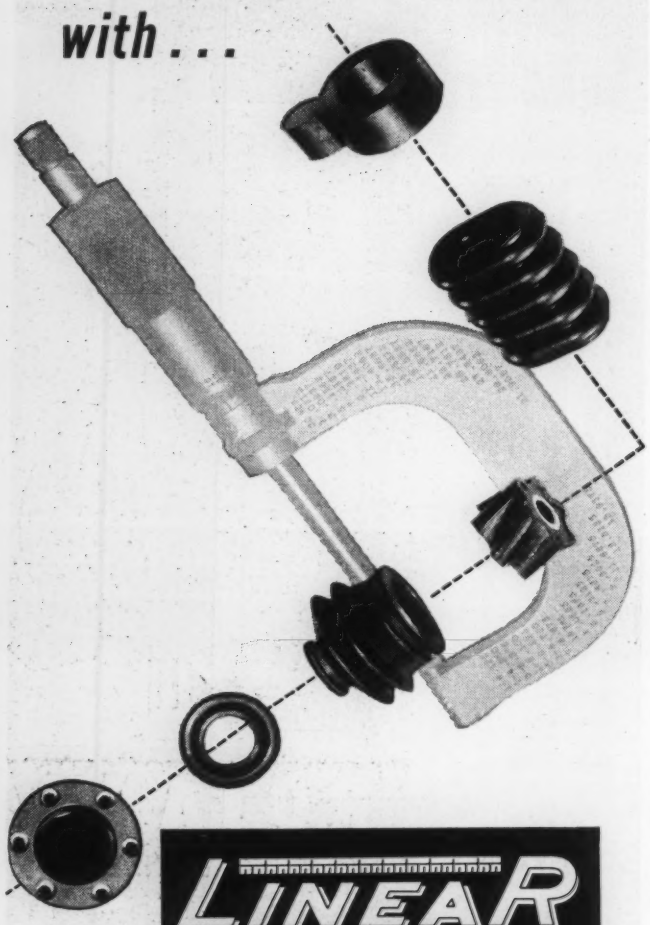
Every Piece Counts

with . . .



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In these difficult times, few companies can afford to waste hard-to-get synthetic or natural rubber parts or to rework rejected assembled units due to faulty or cheaply made rubber pieces. With LINEAR precision mouldings held to the closest possible tolerances, EVERY PIECE COUNTS! This means for you:

- ✻ A lower rejection rate
- ✻ Easier installation
- ✻ Promised schedules maintained

So if you require seals or odd-shaped parts of natural or synthetic rubbers, fluorethylene polymers or silastics to precision dimensions, consult LINEAR during the design stage.

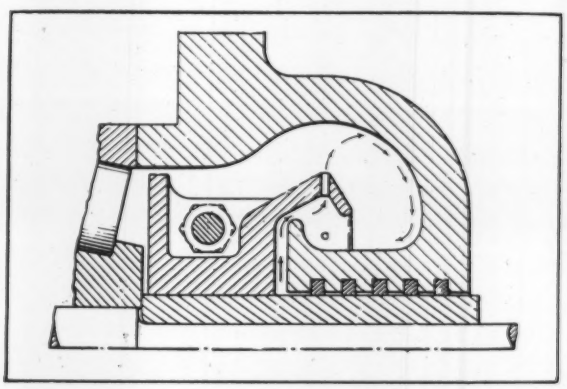
"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILADELPHIA 35, PA.

NOTEWORTHY PATENTS

BEARING SEAL covered in patent 2,524,124 employs a flange outboard of and close to the shaft bearing which deflects most of the lubricant back into the bearing or onto the seal housing. Fluid leaking past this flange is thrown radially to the walls of a stationary annular collecting chamber and by a centrifugal slinger or impeller drains to the sump. This impeller also acts as a blower, maintaining a slight vacuum in the collecting chamber by drawing air from



outside the housing along the shaft, into the collecting chamber and through the drain to the sump. Soap type grease rings or conventional fabric packing keep dirt from entering the seal and provide sufficient resistance to air flow to help create the low pressure area in the seal. Eugene E. Gyana has assigned the patent to United States Rubber Co.

VIBRATOR-CONTROLLED, CONSTANT-SPEED direct-current electric motor, covered in patent 2,538,216, operates at a speed set by the natural frequency of the vibrator. Two armature elements, each carrying four poles, are mounted on the same shaft angularly displaced by a distance equal to one-half the pole spacing. An eight-pole magnet member is carried by the same shaft. Rotation of this magnet causes north and south poles to alternately attract and repel a flat-spring mounted magnetic vibrator, which makes and breaks two contacts supplying direct-current power to the two windings. With four poles on each of the armatures, a vibrator natural frequency of 40 cycles per second, for instance, gives a shaft speed of 600 rpm. Speed of the motor can be adjusted by changing the number of poles on the armatures or the natural frequency of the vibrator, or both. The motor described in this patent, assigned to Automatic Electric Laboratories Inc. by

Touch ...and GO

Thirty-two years ago, one of the weakest points in many machines was the vital connecting link between driving and driven units. This isn't true today.

Now, wherever you see power at work—in factories, in oil fields, in construction camps, in the logging country, in boats—the transmission of power to start the work cycle is merely a matter of *touch... and GO.*

And chances are, the sensitive but tough power transmission mechanism was manufactured by the Twin Disc Clutch Company—the world's largest supplier of industrial clutches.

In its 32 years, too, Twin Disc has pioneered in hydraulic power transmission—today offers the nation's most complete line of hydraulic torque converters and hydraulic couplings for industrial application.

So, whatever your problem in "touch and GO" power transmission may be, let Twin Disc Engineers submit a recommendation. Their experience and the facilities behind them are unexcelled in the industrial power transmission field.

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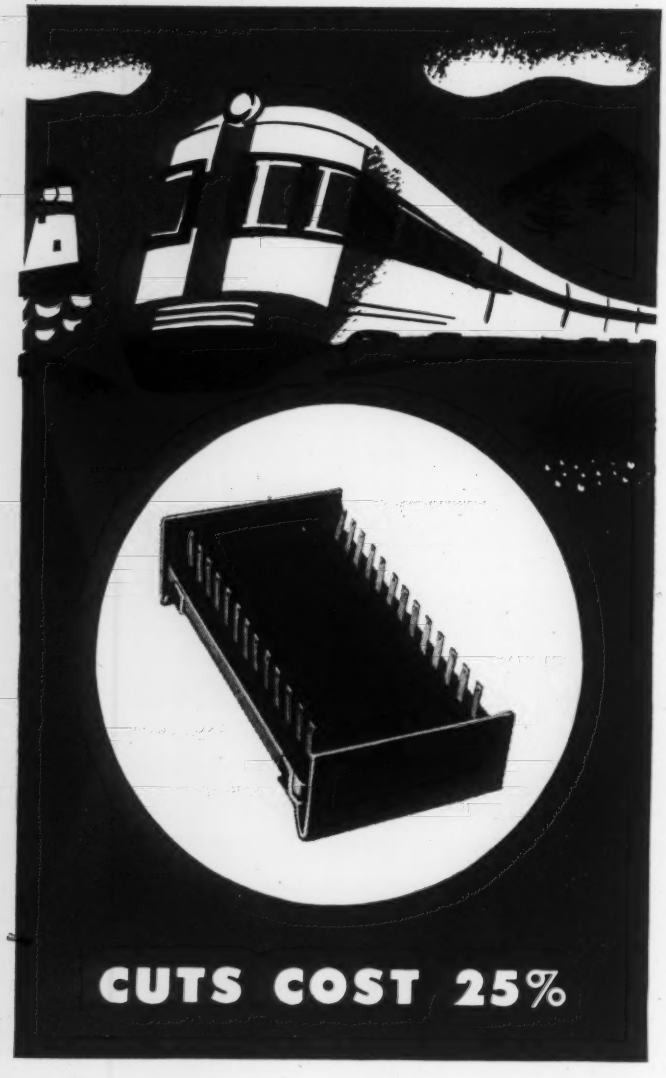
TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois



without sacrificing passenger comfort

That multi-tapped channel resistor is a Ward Leonard suggestion to reduce the cost of maintaining constant voltage for a Diesel train's auxiliary services over the entire speed range.

Originally, the voltage regulator used 16 multi-tapped resistor tubes to give 50 resistance steps. Substituting two multi-tapped Ward Leonard channel resistors simplified mounting so as to save 25% in overall costs.

So you don't have to buy a *cheaper* resistor to make a saving. A better way is to let Ward Leonard do the job for less cost, with a quality product and an engineering *idea.*

Ship *your* problem our way.

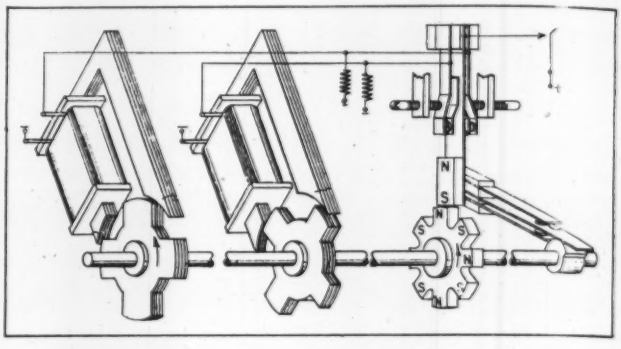
WARD LEONARD ELECTRIC CO., 58 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WARD LEONARD ELECTRIC COMPANY

Result-Engineered Controls Since 1892

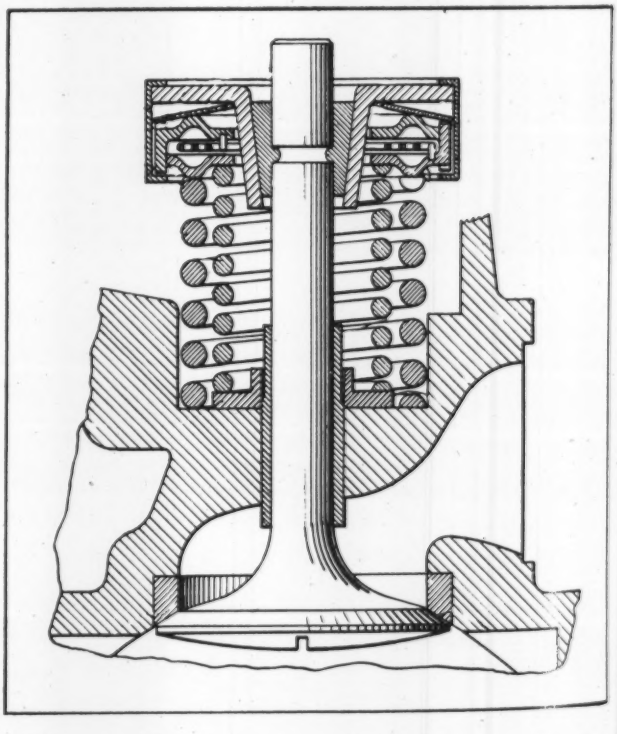
RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

Rudolph F. Stehlik, has no dead centers since one or the other of the contacts attached to the flat vibrator spring is always closed when current to the



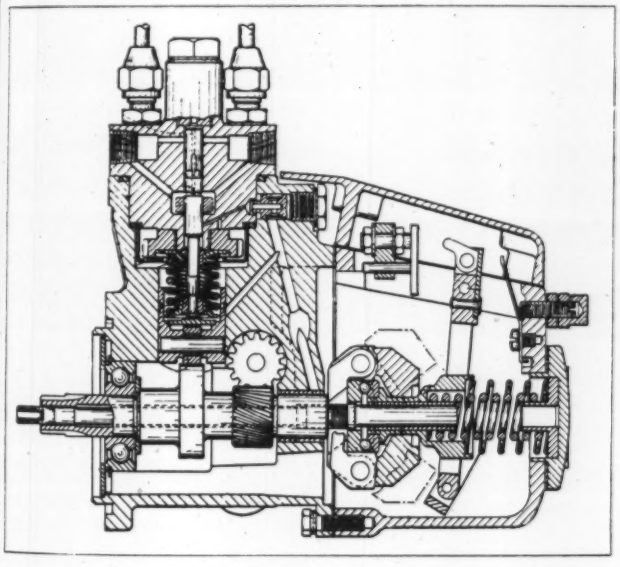
armature is interrupted. When the current is restored, therefore, one of the windings is immediately energized to start the motor.

ROTATING THE VALVES in internal combustion engines, thus reducing carbon deposits, valve wear due to uneven seating, and leakage, is most effective when the valve is rotated in its open position. A device to accomplish this is covered in patent 2,516,795, assigned to Thompson Products Inc. by Samuel H. Norton. Substituted for the conventional valve spring retainer mechanism, the rotating device uses disk members so disposed that tapered lugs or teeth on one member contact similar teeth on the other member. As load is applied to the valve stem, the toothed disks are forced closer together in the axial



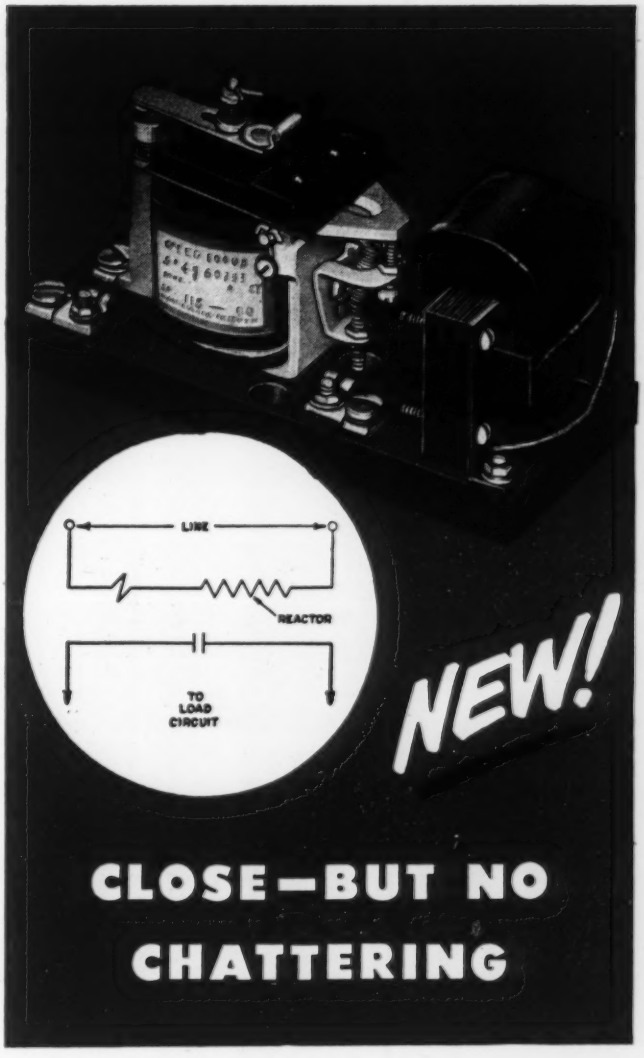
direction, with the tapered faces of the lugs engaging and rotating the disks relative to one another. Through the compressed conical spring washer between the upper disk and the spring retainer, the valve retainer and valve stem are rotated. When load is removed from the valve stem, a small torsion spring located between the disks rotates them back to their original positions, the relaxed spring washer permitting the upper disk to slip relative to the valve stem retainer.

ROTATION of a single, ported injection pump plunger is combined with a reciprocating pumping stroke to provide equal fuel distribution to multiple engine cylinders. Described in patent 2,518,473, the pump also incorporates a governor-controlled adjustment of the quantity of fuel delivered to each of the cylinders. The plunger is reciprocated by a cam



mounted on an engine-driven shaft and is simultaneously rotated by a gear train drive from the same shaft. Porting in the pump body determines the time when injection to any one of the outlet lines begins; a sliding sleeve linked to the governor controls the position of a spill groove, in relation to the plunger, and thus automaticaly regulates the quantity of fluid injected. Plunger rotation and travel are synchronized by the gearing so that successive outlet ports are lined up at the same time that the plunger is on its injection stroke. This construction, outlined in the patent granted to Hans Hogeman and Frank S. Coe and assigned to American Bosch Corp., requires a minimum of precision lapped fits and accurately calibrated discharge check valves and, by utilizing the same delivery valve and metering means for all the outlets, assures equal distribution to each spray valve.

Complete printed copies of all patents are available from the Commissioner of Patents, Washington 25, D. C., for 25 cents each.



New A-C voltage-sensitive relay makes ideal safety device

Bulletin 401 describes how voltage differential between pick-up and drop-out can be set at 10% (5% on special order)—without chattering—on Ward Leonard's new a-c magnetic relay.

Designed for safeguarding single phase a-c motors (such as on washing machines, oil burners, etc.) against burn-out caused by low voltage, the 401 relay is also ideal for a-c lighting and power bus transfer, voltage regulating, etc.

A small saturable reactor, connected in series with the relay coil, acts as a variable impedance, varying with voltage drop. Since it is the major impedance in the circuit, wide current variations through the coil can be obtained with small line voltage variations.

Being a power-type relay, it provides good contact, good make-and-break. Write for Bulletin 401. WARD LEONARD ELECTRIC CO., 58 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

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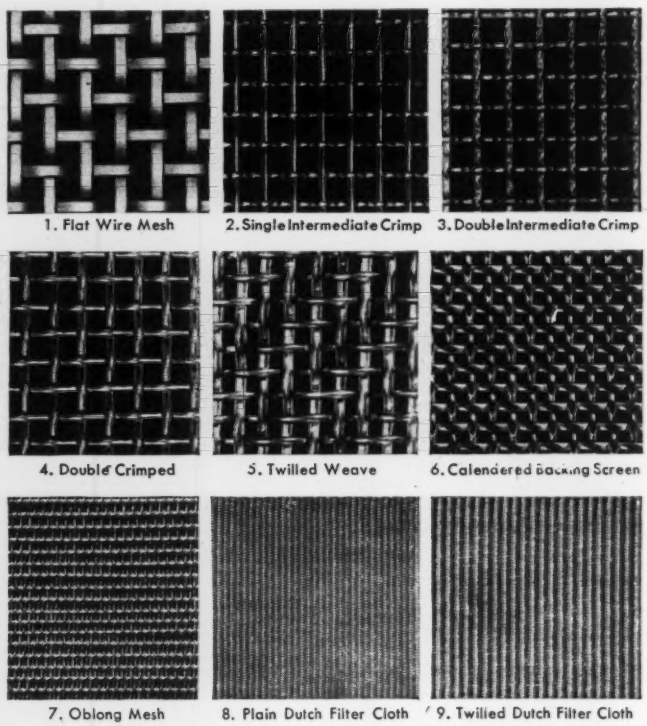
9 REASONS for specifying *Cambridge* Industrial Wire Cloth



1. Flat Wire Mesh
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3. Double Intermediate Crimp
4. Double Crimped
5. Twilled Weave
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8. Plain Dutch Filter Cloth
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Select the wire cloth that meets your requirements best from these 9 basic Cambridge weaves. Each is available to you in any metal or alloy wire of any gauge. Mesh sizes range from 4" openings to 20 x 250 mesh, according to your needs. *Many types of Cambridge wire cloth are ready for immediate shipment.*

Close attention to each loom by individual operators during weaving is your assurance of exact mesh count. Each finished piece is carefully inspected before shipment to make certain it is free from defects.

Tell us your special problem in filtration, screening or sizing. Perhaps our facilities and experience can be combined to produce the special type of wire cloth needed.

FREE WIRE CLOTH HANDBOOK! 73 pages of specifications, metallurgical data and descriptions of industrial wire cloth. WRITE TODAY for your copy of this valuable reference book.

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Ultrasonics

By Benson Carlin, Hillyer Instrument Co. Inc.; published by McGraw-Hill Book Co. Inc., New York; 270 pages, 6 by 9 inches, clothbound; available through MACHINE DESIGN, *$5.00 postpaid.*

Vibrational waves of a frequency above the normal ear hearing range have become of great importance in recent years. Their unique properties have been applied to industrial, experimental and other fields in such capacities as: materials testing, television photography, dispersion of metals in liquids, military detection, precipitation of smoke, production of heating effects, transformation of chemical compounds and crystal structures, etc.

This volume deals with the many engineering aspects of the ultrasonic field. Theory and methods of generating the waves are covered comprehensively. Important theoretical considerations are presented as statements of fact without histories of development. Electronic considerations and outlines of circuits are specifically reviewed. Mechanical and electrical design of ultrasonic systems are discussed, and illustrations are slanted to give definite guidance to the designer in the field.

The designer should, through this book, become sufficiently acquainted with the field of ultrasonics so as to be able to intelligently probe the possibilities of further industrial application of these high-frequency vibrational waves.

□ □ □

The Nomogram

By H. J. Allcock, Callender's Cable and Construction Co. Ltd., and J. Reginald Jones, St. Catherine's College; revised by J. G. L. Michel, Mathematics Division of the National Physical Laboratory; published by Pitman Publishing Corp., New York; 238 pages, 6 by 9 inches, clothbound; available through MACHINE DESIGN, *$3.75 postpaid.*

Designers are often faced with the problem of making a large number of calculations using the same formula but employing different sets of values for the variables. Many times, where addition as well as multiplication is involved, the slide rule or tables of logarithms require tedious solution methods. A great deal of labor can be avoided and design work facilitated by nomograms—diagrams giving formula solutions. On a nomogram, each variable is represented

More time for creative drafting!

Look at just two of the ways Kodagraph Autopositive Paper saves valuable drafting time for the Cleveland Crane and Engineering Company.

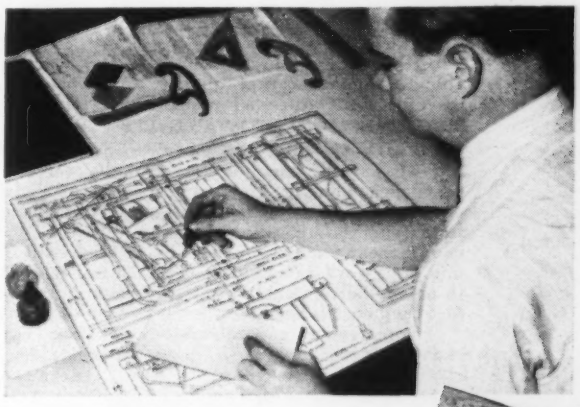
The chances are you'll be able to take similar short-cuts in your work . . . *turn hours of costly retracing time into hours of creative drafting time.*

1 Time saved . . . when drawings must be combined

Many clients order custom jobs requiring electrical components which Cleveland Crane must obtain from outside vendors. Oftentimes, the designs for several of these units must be combined in one drawing before original drafting can begin. This used to be a tedious retracing job—*but no longer.* Now, desired sections of the vendors' prints are reproduced as a composite print on "Autopositive" Paper. Exposure is in a direct-process machine; processing is in standard photographic solutions. The result is a sparkling positive intermediate . . . with dense photographic black lines on a clean, evenly translucent base. On it, the draftsman simply adds the necessary wiring detail . . . producing a new "master" in a fraction of the old time.

2 Time saved . . . when drawings must be changed

New design must replace old detail on complicated switch assembly drawings. *And Cleveland Crane is doing the job the easy way:* instead of making a new drawing—which would be 85% retracing—they reproduce the original one on Kodagraph Autopositive Paper. Then the draftsman removes the unwanted lines from the intermediate print with corrector fluid . . . and draws in the new detail. Result: a brand-new "original" is ready in three hours instead of 3 days. *Ready* to produce sharp, legible shop prints in the desired number.



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"The Big New Plus" in engineering drawing reproduction

- **It enables you, or your blueprinter, to produce positive photographic intermediates directly at a new, low cost.**
- **It enables you to reclaim old, weak-lined drawings . . . reproduce opaque originals and prints.**
- **It protects your valuable originals . . . produces more legible shop prints.**

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When you stop to think of it there are two opposed objectives in almost every designing job: product improvement with little or no increase in cost. It's a tough assignment that leaves only pennies and ingenuity to work with.

In striving to fill this difficult order, it's always profitable to remember that quality Aetna bearings do for a machine what salt and pepper does for a meal—CONTRIBUTE MORE TOWARD ITS SUCCESS, AT LESS COST, THAN MOST ANY OTHER FACTOR.

That's why engineers are rapidly turning to Aetna bearings as an easy, low-cost approach to substantial product improvement. Chances are, you too can benefit by letting Aetna engineers institute a "search for savings" analysis of your present products or those in the blue-print stage. You'll find their work painstaking and practical with one thought in mind—betterment of your products within your manufacturing cost limitations.

Tomorrow's unpredictable conditions demand that today's new machines be, dollar-for-dollar, the most efficient, most durable ever made. And . . Aetna stands ready to help you in that endeavor.

AETNA BALL AND ROLLER BEARING COMPANY
4600 SCHUBERT AVENUE • CHICAGO 39, ILLINOIS

by one or more graduated lines. From such a diagram, the unknown value of a formula may be determined usually by use of a straight edge to join the known values. Permanent charts may be created to solve many problems of varying complexity.

This book, a fourth edition, comprehensively shows how to construct nomograms. Coverage ranges from the fundamental straight-line scales for one variable through the fourth and higher-order nomograms of as many as seven variables. In developing each type of nomogram, the authors explain the determinants involved, the layout work, and several representative examples. The illustrative examples are developed step by step to the nomogram stage, a presentation which should prove a valuable guide to the designer who wishes to create nomograms for his specific problems.

Three sections at the end of the book provide excellent quick reference to the standard form of the third class (three-variable) nomogram, its basic determinants, the mathematical transformation of determinants, and Sarrus' rule.

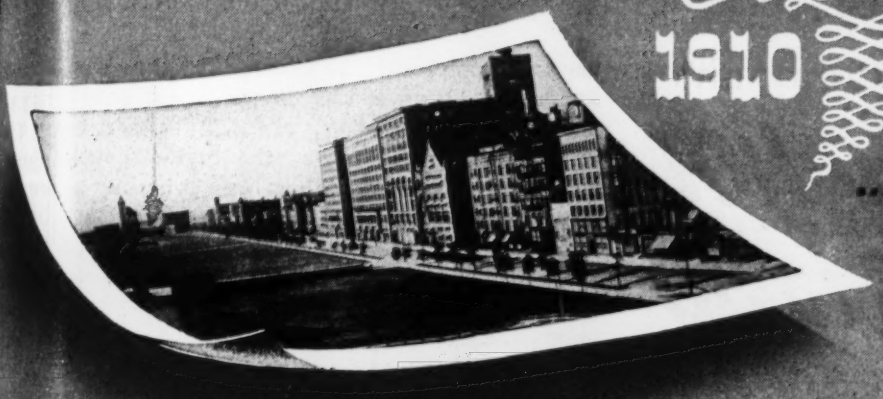
To those who may have seen previous editions of this book, several amendments and corrections will be evident. A complete chapter has been added showing the relation between intersection and alignment nomograms. Appendix III, which deals with the formation of basic determinants for third class nomograms, is also new.

Government Publications

Analysis of Plane-Stress Problems with Axial Symmetry in Strain-Hardening Range—NACA TN2217 by M. H. Lee Wu: A method, based on the deformation theory and employing the finite-strain concept, was developed to solve plane-stress problems in the strain hardening range of circular membranes, rotating disks, and infinite plates with circular holes. Distributions of octahedral shear strain, as well as the principal stresses and strains, were obtained. Results show that ratios of principal stresses remain essentially constant during loading; distributions of strain in the plastic case are less uniform than in the elastic case, although distributions of stress are more uniform; deformation that can be accepted by the member depends mainly on the maximum octahedral shear strain on the material; and the added load that the member can sustain between the onset of yielding and failure depends on the octahedral stress-strain relation of the material.

Copies of this report may be obtained from the National Advisory Committee for Aeronautics, 1724 F St., NW, Washington 25, D. C.

A Structural-Efficiency Evaluation of Titanium at Normal and Elevated Temperatures—NACA TN 2269 by George J. Heimerl and Paul F. Barrett: A structural efficiency evaluation of titanium, including comparisons with several other materials, is given for compressive loading without buckling of long



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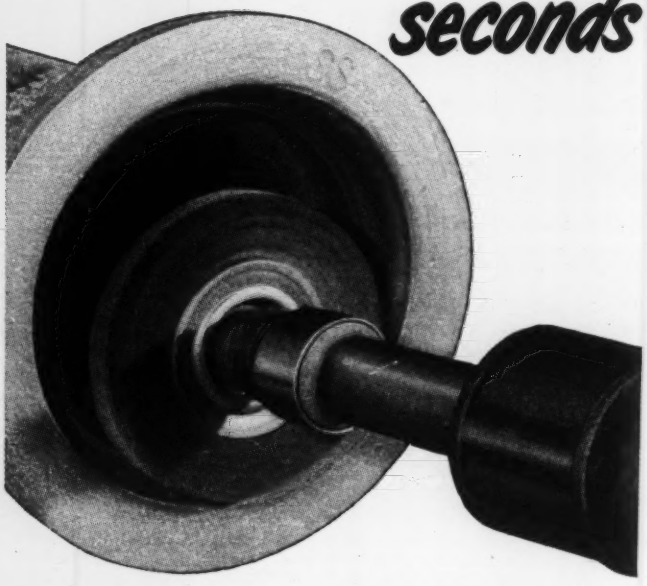
1951

This Special Pittsburgh Brush*

CLEANS RED-HOT CASTINGS in 30 seconds



* *An actual case history from the U. S. Pipe and Foundry Company, Birmingham, Alabama*

A PITTSBURGH brush provides the answer for U. S. Pipe and Foundry's problem of cleaning red-hot castings. This rugged brush works 40 hours a week, turning out thoroughly cleaned castings at the rate of one every 30 seconds . . . a speed record for any brush cleaning operation of this type.

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Pittsburgh's complete line of brushes of every type, for every purpose, will provide a practical, economical solution of any brush problem you might have. Drop us a line on your company letterhead for a copy of our new booklet that shows, through actual case histories, how Pittsburgh can help cut your brushing operation costs. Address: PITTSBURGH PLATE GLASS COMPANY, *Brush Div.*, Dept. W1, 3221 Frederick Ave., Baltimore 29, Md.

PITTSBURGH

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plates in compression or shear. The methods of evaluation, based upon the use of stress-strain curves and structural indexes, are fully described. The comparisons indicate that the high-strength aluminum and magnesium alloys are generally more efficient on a unit-weight basis at normal temperatures than commercially pure titanium sheet. For short-time loading conditions at temperatures beginning somewhat above 400 F, titanium sheet is more efficient than the aluminum alloys.

Copies of this report may be obtained from the National Advisory Committee for Aeronautics, 1724 F St., NW, Washington 25, D. C.

New Standards

Apparatus Noise Measurement ASA Z24.7—1950: Sponsored by the Acoustical Society of America, this standard defines uniform methods for conducting and recording sound-level tests on apparatus. The standard includes procedures for factory tests of equipment, field investigations and sound-level specifications. The section devoted to factory tests contains information on methods for measurement of direct air-borne noise; reflected sound; apparatus mounting; location of microphone, including tentative distances from the microphone for specific types of equipment; standing waves; record of measurements; and noise measurements.

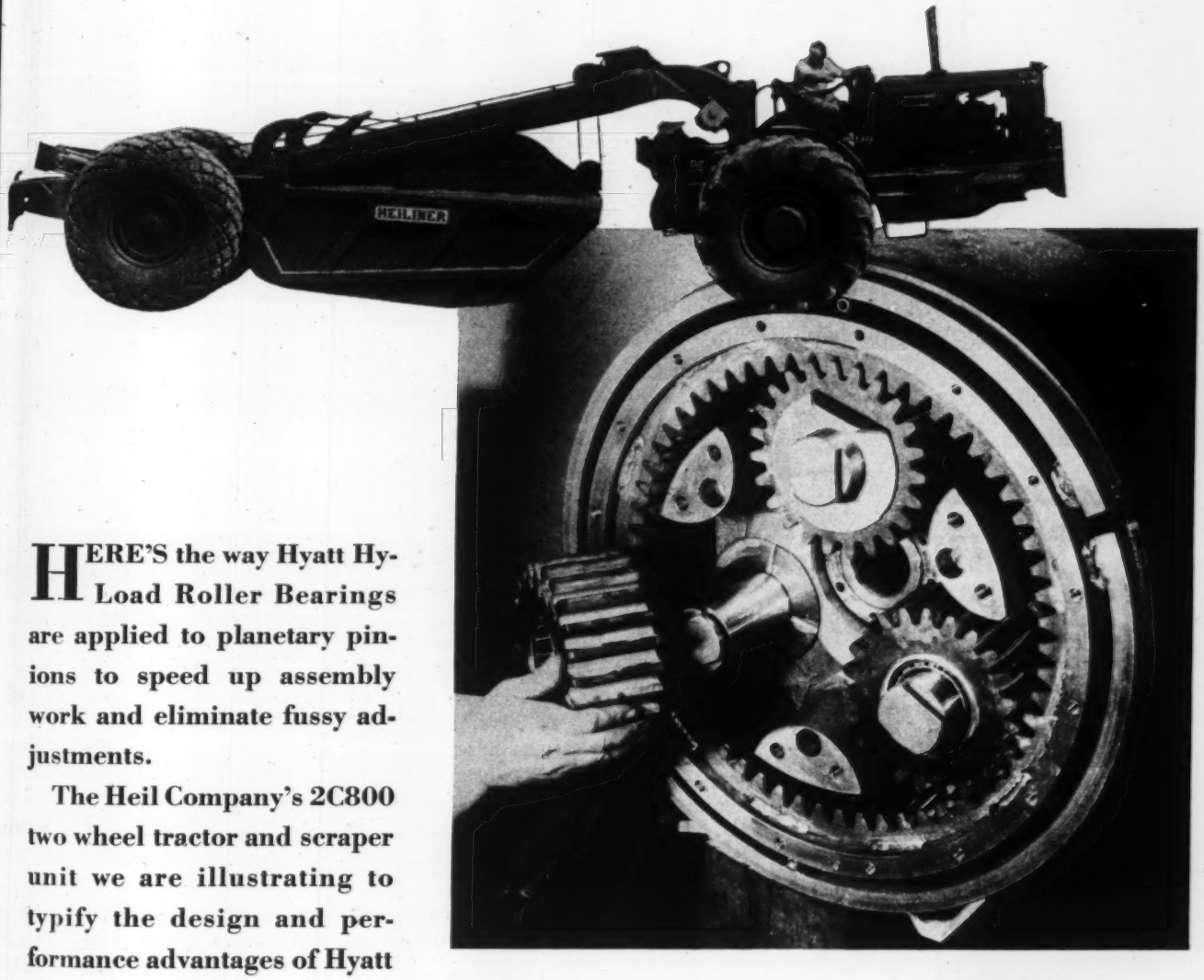
Copies of the standard may be obtained from the American Standards Association, 70 East 45 St., New York 17, N. Y., at $0.50 per copy.

SAE Automotive Drafting Standards — SP-66: These standards are intended primarily to guide the designer of the automotive industry toward uniform presentation of his product design, although they may also serve as a supplementary reference for engineering instructors and students. The standards are published without commitment as to their finality for they may be changed to assist in the unification of national drafting practices. SAE will consider suggestions for improvement.

The standards are presented in two parts: thirteen sections deal with the basic fundamentals of engineering drawing, and eight sections with design details, abbreviations, and definitions of terms. Included in the first part are suggestions for drawing forms, line work, lettering, projections, dimensioning, limits and tolerances, screw threads, drawing revisions, layout forms, layout practice, and checking practice. The second part contains suggestions for proper presentation of designs involving sand casting, die casting, springs, powder metallurgy, surface finishes, and chassis frames.

Copies of the standards may be obtained from the Society of Automotive Engineers Inc., 29 W. 39th St., New York 18, N. Y. Price of the looseleaf form, which is ready for insertion in a standard three-ring binder, is $3.00; binders are available at an additional cost of $2.00 each.

Another Example of Improved Design and Performance with HYATTS

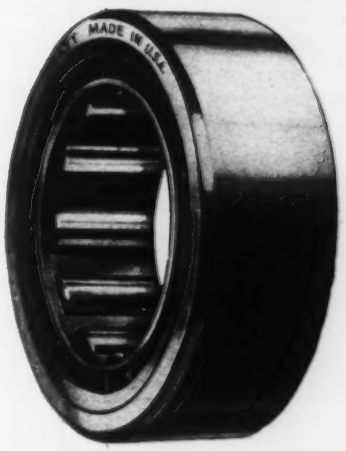


HERE'S the way Hyatt Hy-Load Roller Bearings are applied to planetary pinions to speed up assembly work and eliminate fussy adjustments.

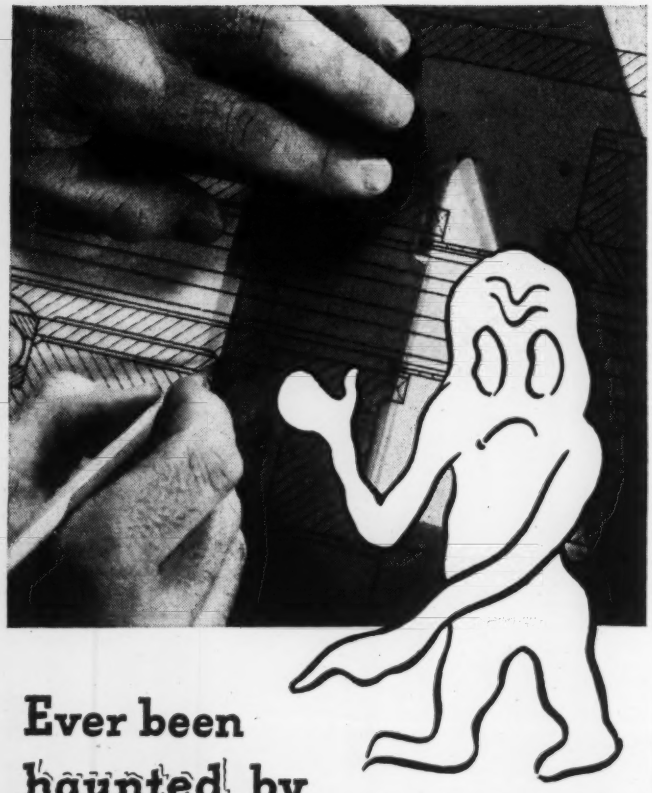
The Heil Company's 2C800 two wheel tractor and scraper unit we are illustrating to typify the design and performance advantages of Hyatt Roller Bearings.

Along with these pinion applications other Hyatt Roller Bearings . . . forty-eight in all . . . are used throughout this entire Heil tractor and scraper unit to insure further construction advantages and dependable, trouble-free operation for the life of the equipment.

All of which proves that it pays to build Hyatts into the machines you manufacture or look for them in the equipment you buy. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.



HYATT ROLLER BEARINGS



Ever been haunted by an "ERASURE GHOST"?

The beauty of Arkwright Tracing Cloth is its *permanent* translucency — built all the way through the cloth by a special process. Arkwright will take the heaviest erasures without "ghosting". You can count on clear, clean prints from drawings on Arkwright cloth years after you make them.

You can re-ink over erasures on Arkwright Tracing Cloth without feathering or "blobbing". You can be sure there are no pinholes, thick threads or other imperfections in the cloth to bother you. Every roll is carefully inspected before leaving the factory.

Think a moment. Isn't it an unnecessary risk to put your important drawings on inferior tracing cloth or paper? A sample will show you the difference. Write Arkwright Finishing Company, Providence, R. I.

ARKWRIGHT
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AMERICA'S STANDARD FOR OVER 25 YEARS

Mechanical Properties of Metals

(*Continued from Page* 148)

square inch and hence appear to be design values but actually are not, since it is almost inevitable that an actual part will have some stress raiser present. The conventional endurance test merely gives par for the material tested.

In order to get closer to practical conditions, a *notched fatigue* test may be made. But the notch adopted represents only one stress raiser, whereas the practical part may have any other, such as different fillets or a hole, as in *Fig.* 9 from Dolan.[8] Hence though such fatigue tests are reported in pounds per square inch, they again are not precise design values. Similarly, a corrosion fatigue test, made in contact with some corrosive liquid, at some particular rate of repeated loading, does not give directly applicable values for other liquids or other rates.

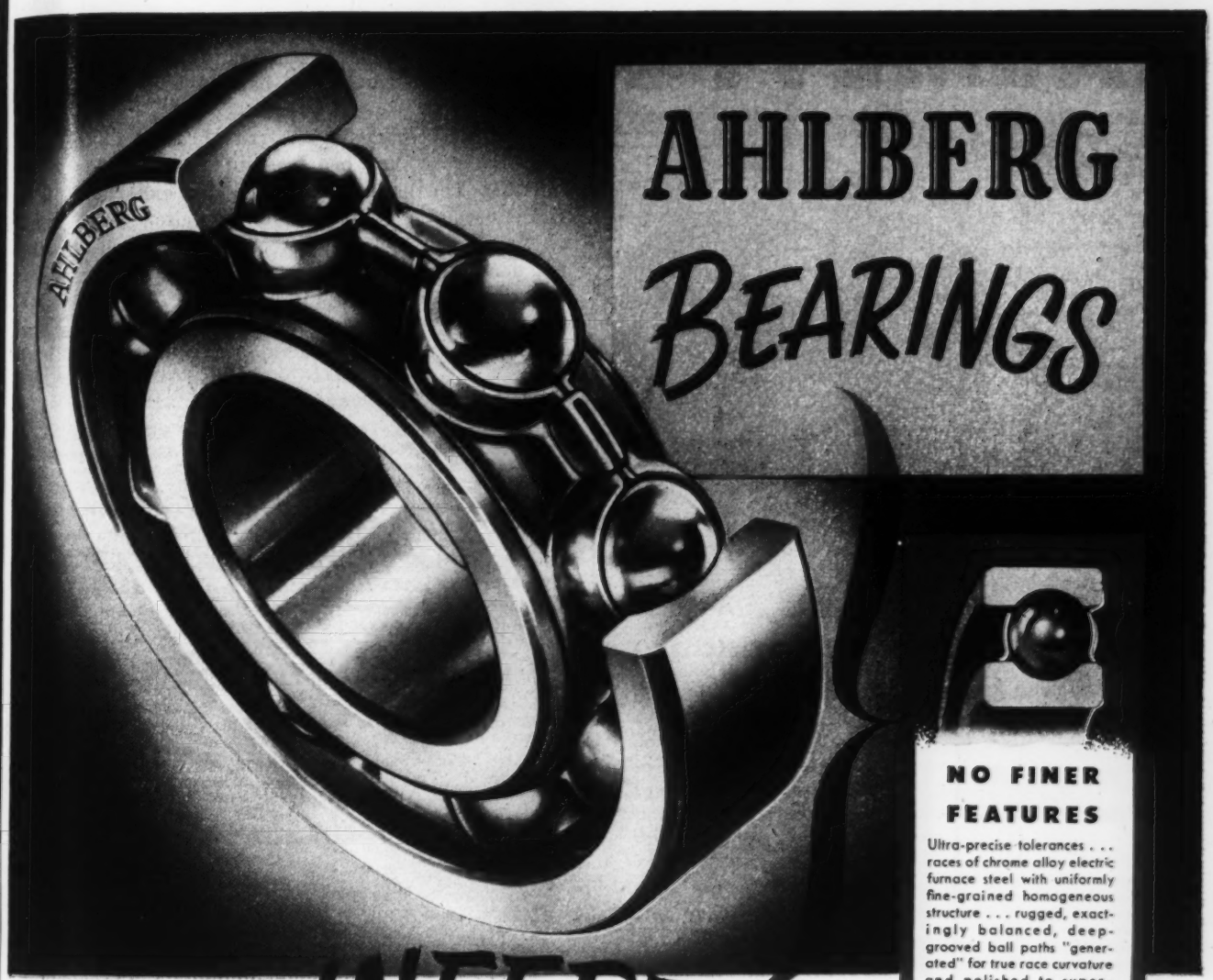
HIGH TEMPERATURE: High-temperature behavior, sought to be evaluated by short-time high-temperature tensile tests, is not so evaluated unless the service time is as short as the testing time. It is more approximately evaluated by creep tests, ordinarily carried out for 1000 to 3000 hr and then extrapolated to, say, 20 yr. The uncertainties of such extrapolation make the creep values, which are in pounds per square inch, nevertheless nothing better than an approximation.

Another method of evaluation of high-temperature behavior is by *stress rupture,* loading a series of bars at different high loads and noting the time to fracture. This is an unrealistic test, since design is for life, not for fracture, and its results are frequently misleading. Creep and stress-rupture tests need to be accompanied by a study of the stability of the structure.

CONCLUSIONS: All the conventional tests have serious and definite limitations in appraising the actual behavior of metals and alloys; they merely supply bits and pieces of *qualitative* information, sometimes helpful when they measure or imply a characteristic necessary in a particular service, but a waste of time when they do not so measure or imply. There are other tests designed to show the presence of cracks or dangerous stress concentrations in individual parts and thus incidentally to reveal the relative propensity of different alloys under different treatments to display these failings.

No Conventional Tests for Many Properties

Then there are many attributes, necessary to consider in the behavior of metals, such as machinability, corrodibility, weldability, wear resistance, for which no conventional test is applicable, but each of which must be appraised by experience in actual service or tested for by closely reproducing the conditions of service. Thus, an appraisal of the chances for the selection of a material that will display proper behavior in a given service must rest on a balancing of



NO FINER FEATURES

Ultra-precise tolerances . . . races of chrome alloy electric furnace steel with uniformly fine-grained homogeneous structure . . . rugged, exactingly balanced, deep-grooved ball paths "generated" for true race curvature and polished to super-smoothness . . . micro-lapped chrome steel balls matched in sets and sphericity to within .000025".

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TO COST LESS BY LASTING LONGER

We've seen the time, in this business of ours, when bearing users often made their selections on a look-alike, serve-alike theory. But technological progress, the squeezing of machinery tolerances, the stepped-up speeds and loads required in our modern mechanized world have long since changed all that—a change we've welcomed because Ahlberg bearings have always been designed and built on the principal that there is no substitute for quality—that only longer-lasting, ultra-smooth running bearings are actually an economy.

Next time you design a new machine or modernize an old one, a point by point comparison will give you convincing proof of Ahlberg superiority and further evidence of how better bearings make better products. We'll be glad to collaborate closely with your engineers and submit quotations without obligation. Write today! Ahlberg Bearing Company, 3025 West 47th Street, Chicago 32, Illinois.

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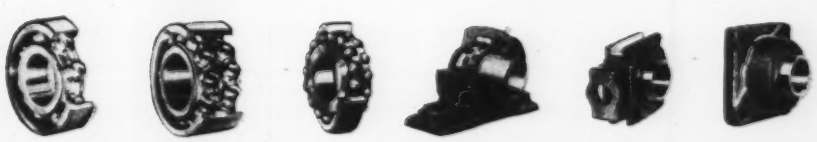

BALL BEARINGS · · · ROLLER BEARINGS · · · THRUST BEARINGS AND BALL BEARING HOUSINGS

PALMETTO®

patterns-a ring on a square

for sturdier vee-packing performance

In designing Pyramid® Packing, Palmetto Packing Specialists **patterned each ring on a square**—to gain the balance of a uniform cross section (each ring sits squat and true . . . there's no chance of cocking or rolling)—to gain the strength of heavier and uniform wall construction (each ring is rugged at the hinge—there's no chance of damage through splitting).

Another plus in Palmetto's balanced design: Two-thirds of the lateral packing surface is sealing surface—which means fewer rings per stuffing box.

And this is just a part of the job accomplished by Palmetto Packing Specialists for improved and prolonged vee-packing performance.

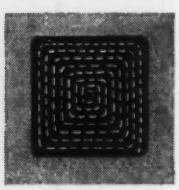

Fig. 1

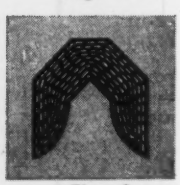

Fig. 2

Because most vee-type packings are laminated, wearing surfaces tend to fray and cause leakage. No chance of that here, for the fabric is folded endlessly into a square (Fig. 1), then molded (Fig. 2), leaving no raw edges to wear, break down and impair efficiency.

The Pyramid is a step and a half ahead of all vee-type packings in design and performance . . . insures automatic, self-compensating packing adjustment to all variations in pressure . . . performs in any stuffing box regardless of motion of rod, shaft or plunger

For the complete facts—the 7-point Design story on Palmetto Pyramid Packing . . .

WRITE FOR BULLETIN MP-20

Palmetto's design of *complete* vee-packing performance is typical. Investigate the "Pyramid" . . . the "G-T Ring®" . . . other packings in the complete Palmetto line. When you have a tough one, think of the Palmetto Packing specialist. He'll have the answer—and it will always be Palmetto-Perfect.

PALMETTO Packings *Specified since 1880*

"WHEN PACKING PERFORMANCE COUNTS"

GREENE, TWEED & CO.

NORTH WALES, PENNSYLVANIA

many attributes, qualitatively appraised, not merely on a few figures taken from a handbook or determined by conventional tests. This balancing is "engineering judgment."

Kettering[9] comments that our present engineering judgment may not be based upon wide enough experience. The simple way to widen experience is to make simulated service tests. He cites the example where a variety of pistons, of orthodox and unorthodox design, were run in a single-cylinder engine, "to find out which the engine liked best." Its choice was not the expected one; "the engine was smarter than the engineers."

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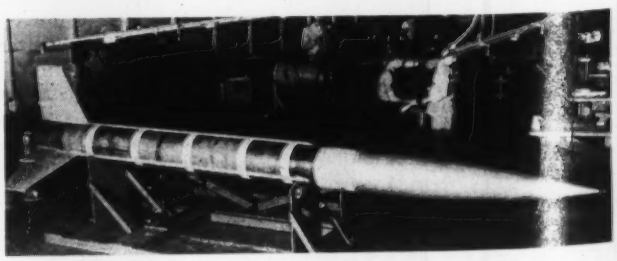
Rockets for Atmosphere Study

A TWO-YEAR high-altitude study of cosmic rays, meteorology, radio characteristics and other unknown facts about the thin upper atmosphere is being conducted by the Air Force using Ryan-built 3000-mph "Aerobee" sounding rockets. These rockets, simpler and cheaper than the famous V-2's, are slender, 20-ft long units using liquid fuel. They have two-stage propulsion: a solid fuel booster rocket first brings the velocity up to 670 mph and then drops off, after which a sustaining liquid-fuel charge drives the rocket at 3000 mph and to heights of 75 miles. The



Aerobee is designed to carry a 150 to 200-lb pay load of instruments which are blown from the nose of the missile at the top of its trajectory and are then lowered by parachute. The rocket also carries telemetering equipment which automatically transmits data by radio to ground stations.

10 new features—31 TIMKEN® bearings in new Kearney & Trecker milling machine

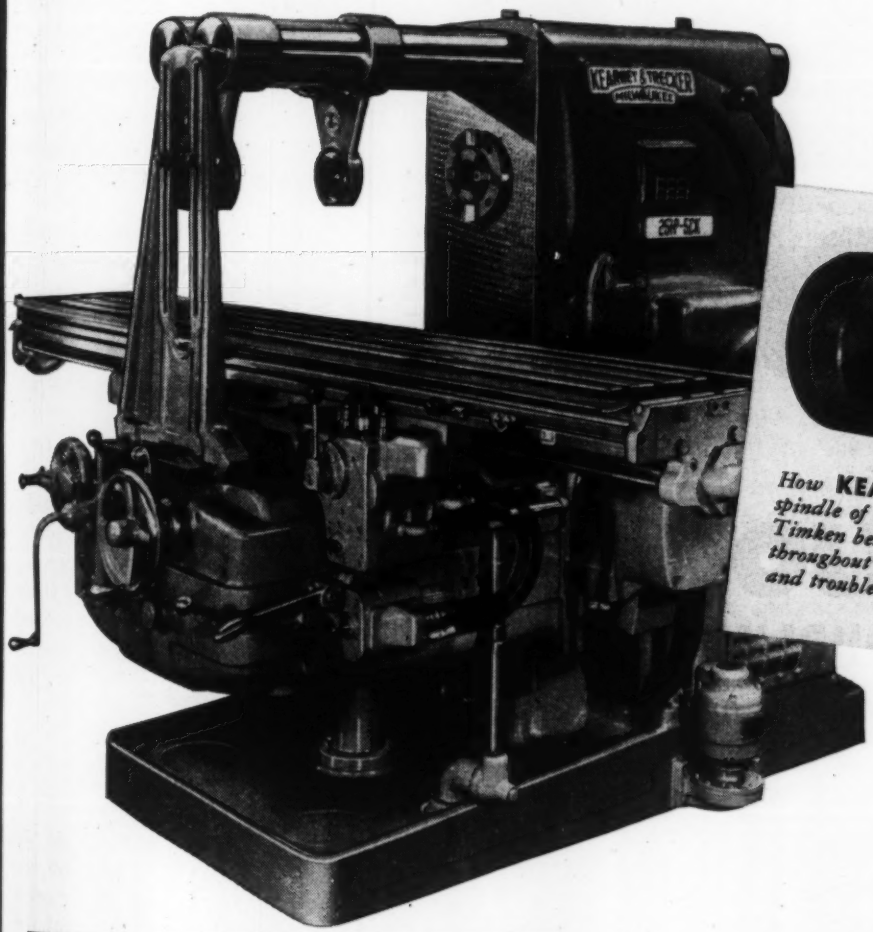
THE new Kearney & Trecker Model "CK" Milling Machine shown below has 10 outstanding new features, ranging from non-glare rapid-set dials to a new and heavier solid-back, sponson design column. And throughout the spindle assembly, feed drive gear box and speed train gear box, there are 31 Timken® bearings to insure greater rigidity, lasting precision and long, trouble-free operation in this new knee-type milling machine.

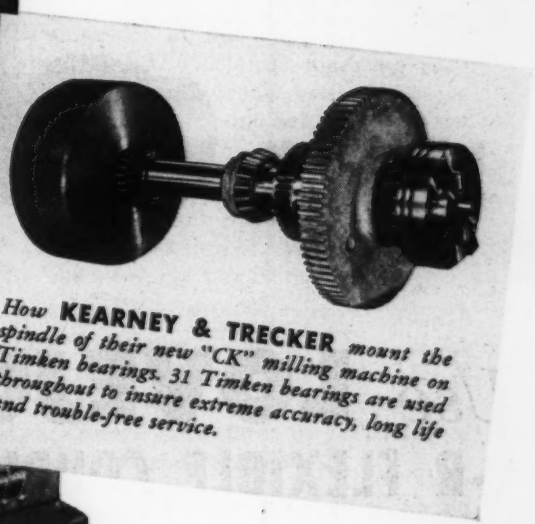
Because of their tapered construction, Timken bearings carry any combination of radial and thrust loads. In the gear boxes, Timken bearings help prevent wear by holding gears and shafts in positive alignment. On the three-bearing spindle, Timken bearings insure long-lasting precision, and permit pre-loading to any desired degree.

Made of Timken fine alloy steel—the finest ever developed for tapered roller bearings—rollers and races have case-hardened, wear-resistant surfaces and tough, shock-resistant cores. Line contact between rollers and races gives extra load-carrying capacity. True rolling motion and incredibly smooth surface finish practically eliminate friction.

Remember, no other bearing can give you *all* the advantages you get with Timken bearings. They're backed by 50 years of bearing research and development and are first choice throughout industry. Whether you build or buy machine tools, insist on bearings with the trade-mark "Timken". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.





How **KEARNEY & TRECKER** *mount the spindle of their new "CK" milling machine on Timken bearings. 31 Timken bearings are used throughout to insure extreme accuracy, long life and trouble-free service.*

IT'S TIMKEN BEARINGS FOR VALUE!

To get the best value in bearings you may find this simple formula helpful:

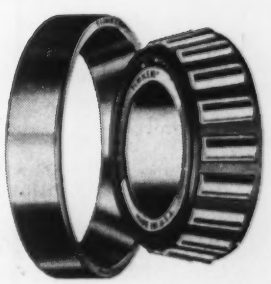
$$Value = \frac{quality + service + public\ acceptance}{price}$$

Obviously a big advantage *above* the line gives you more value than a small one *below*. No other bearing can match the uniform high quality, engineering and field service and overwhelming public acceptance you get with Timken bearings.

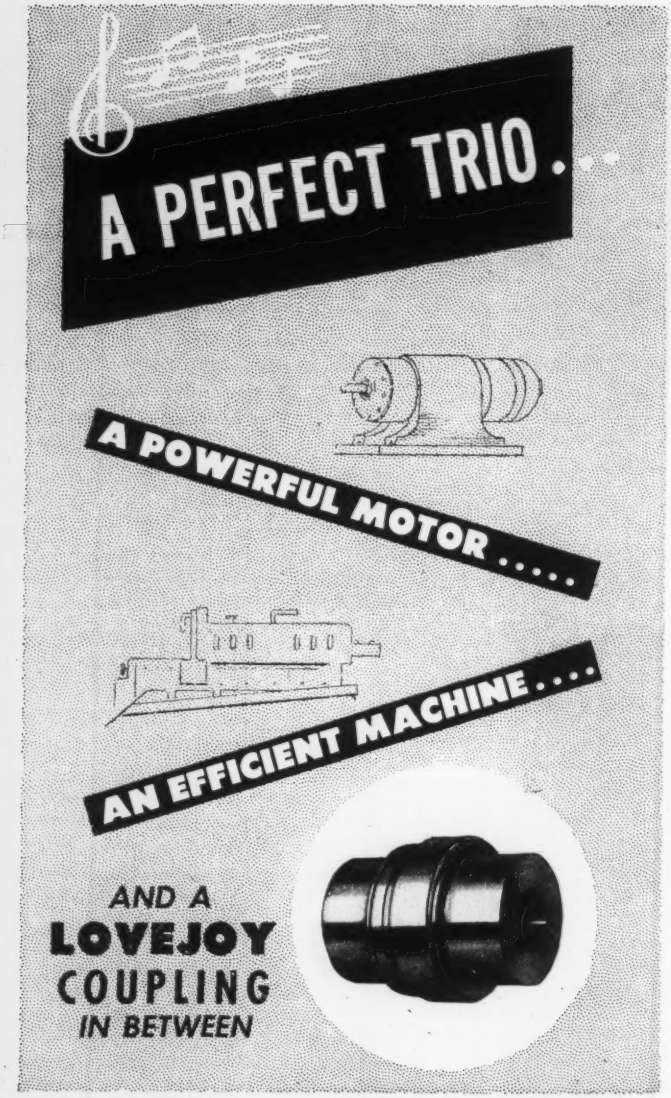
TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ↕ AND THRUST →◎← LOADS OR ANY COMBINATION ✳



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Cam Dynamics

(*Continued from Page* 151)

TRIGONOMETRIC EQUATIONS: Angular functions, though not as easily handled as polynomial forms in satisfying a great variety of conditions, are commonly used in two perennial styles: simple harmonic and cycloidal.

Simple Harmonic: This single-region form appears at first glance to be a satisfactory design because of low maximum acceleration, 4.93 units. However, the occurrence of maximum acceleration at the terminals, $t = 0$ and $t = 1$, gives infinite jerk. This same adverse feature was also noted for the parabolic (second-power) form. The simple-harmonic form, however, is slightly better because finite, instead of infinite, jerk occurs at the midpoint, $t = \frac{1}{2}$.

Cycloidal: The cycloidal, also a single-region form, is superior to both the parabolic and simple harmonic curves with respect to the combination of maximum acceleration (6.3 units), favorable location of its points of application ($t = \frac{1}{4}$ and $\frac{3}{4}$), and maximum jerk (40 units). That these circumstances give greater freedom from vibration was borne out recently in an extensive series of tests.[3] It is to be noted, however, that the derivative of jerk gives an infinity value at $t = 0$ and $t = 1$. Of the polynomials, the fifth-power form most closely parallels the cycloidal in its generally favorable qualities.

CONCLUSIONS: This comparison of profile equations is by no means exhaustive. In showing the relative merits of simple members of the polynomial and trigonometric families, it suggests an approach that might be extended in the development of more satisfactory cam contours.

Another method of profile development, not treated here in detail, has attractive potential in practical cam design: using different types of functions for different regions of a profile. For example, third-power terminal regions can be combined with second-power (parabolic) central regions.[4] By this means, instantly applied acceleration (infinite jerk) is eliminated at the end points of the profile.

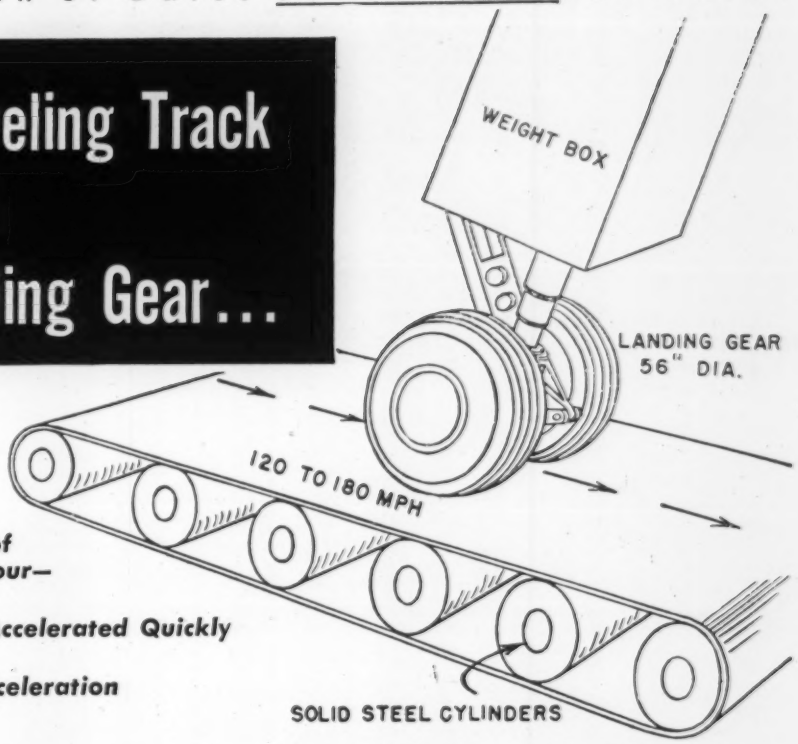
Is Derivative of Jerk Significant?

There is little doubt that jerk is a valuable adjunct to acceleration in the prediction of cam dynamics. Its worth is seemingly confirmed by reported experience[2, 3] and analytic procedures[4] with parabolic, simple harmonic and cycloidal forms. How far the derivative process can be carried with practical advantage is not known at this time. Attention has been called to the first derivative of jerk—the fourth derivative of displacement. This factor, obscured in the complex dynamic behavior of cams and followers, may be significant in high-speed systems.

For all forms illustrated in this article, the rate of change of jerk equals infinity at two or more points. Displacement equations whose fourth derivatives have finite values can be devised easily. Polynomial forms are susceptible to this requirement,[1] and com-

A Practical Application of Gates SPECIALIZED Research

A High-Speed Traveling Track Used to Test Aircraft Landing Gear...



V-Belt Drive Designed by Gates Engineers

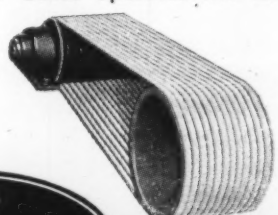
- ***Track Traveling Speed of 120 to 180 miles per hour—***
- ***Massive Weight to be Accelerated Quickly***
- ***Terrific Torque upon Deceleration***

A large Aircraft Manufacturer planned to test aircraft landing gear by dropping the gear onto a track that would travel at airplane landing speeds of 120 to 180 miles per hour. The landing gear would be loaded with weight to equal that of fully loaded aircraft.

Clearly, the shock impact of the loaded gear, its huge wheels motionless, dropping onto the rapidly moving track, would be very great. As the landing gear hits the track, power to the motor is disconnected, permitting the track to travel on its own momentum. To accelerate the huge wheels and slow down the track requires fully 7600 pound feet of torque. Then the drive must bring the massive track mechanism back up to speed in a minimum of time to be ready for the next test.

It was not by accident that Gates Engineers had complete data—*all worked out in advance*—covering the specifications of a V-Belt Drive that has very competently handled this most exacting assignment.

This *pre-solution* of Drive design is possible only because Gates operates the largest V-Belt testing Laboratories in the world. Here, Gates runs an *average* of 32,000 hours of testing *every week* on V-Belts alone! (32,000 hours is equivalent to five years of life for one belt.)



And the real value to *you* of such exhaustive testing is this:—all *results* of these tests are immediately reduced by Gates Application Engineers to *usable data* for the design of V-Belt drives from which *any task whatever* may be required.

Such intensively *SPECIALIZED* Research has naturally given Gates Engineers a most advanced knowledge of V-Belts and V-Belt Drive Design—and the benefit of this advanced knowledge and experience is available to *you, right in your own plant, any time you want it!*

Whether you have a difficult drive to design—whether some V-Belt drive in your plant is giving trouble—or whether you merely want to know what size and construction of V-Belts will give the most efficient and the lowest cost service on a particular drive—you have only to phone a Gates Engineer near you in all industrial centers.

Just look in your phone book under "Gates Rubber." A Gates Engineer will come to you promptly—and he will put at your service the full benefits of Gates unrivaled V-Belt knowledge and experience *without the slightest obligation!*

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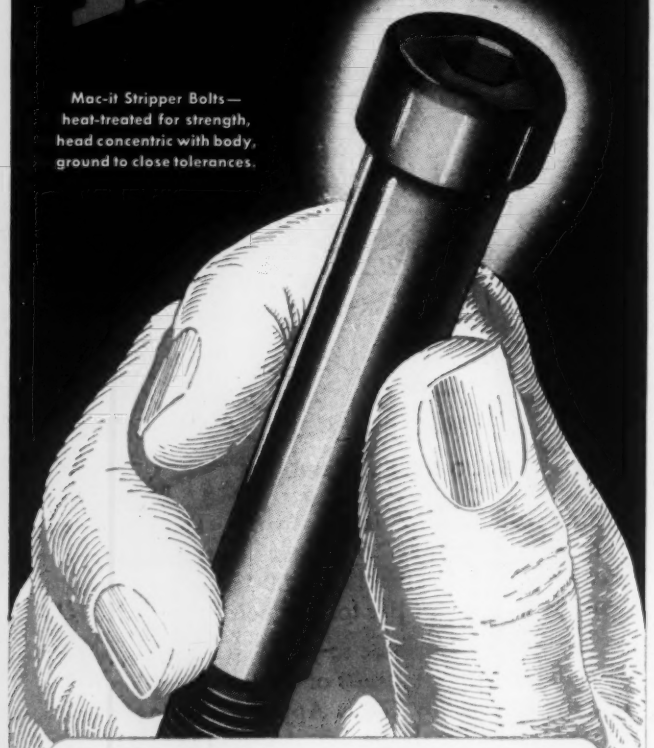

Mac-it Stripper Bolts—heat-treated for strength, head concentric with body, ground to close tolerances.

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Mac-it's 38 years' experience in the manufacture of heat-treated, alloy steel screws is your assurance of precision, uniformity and strength. Sold through leading industrial distributors from coast to coast and in Canada. Write for new catalog today!

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binations of polynomial and trigonometric factors also yield finite rates of change of jerk.

Whether the conceivable and undoubtedly subtle benefits of such a design are worthwhile remains in the realm of the speculative. Profile calculations become more complex and tedious. Practical realization of theoretical advantages additionally requires extreme accuracy in the manufacture of parts. Only test will show the merits of extending the concept of jerk to its derivative.

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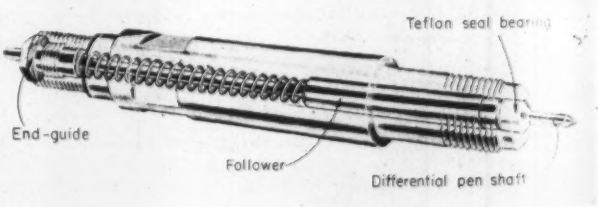
Stuffing Box for High-Pressure Orifice Meter

LEAKPROOF at 5000 psi, this orifice meter stuffing box reduces meter maintenance and leakage troubles at the most frequent point of field service—the pen shaft which transmits motion of the meter's float and lies between high-working-pressure zones in the manometer and atmospheric-pressure zones in the chart case.

The heart of the new stuffing box, made by the Pittsburgh Equitable Meter Div., Rockwell Manufacturing Co., is a combination packing and bearing machined from Teflon which is tough and chemically resistant to water and all reagents (even sulfuric acid) except the molten alkalis. It can take up to 450 F. Properties of Teflon which suggested its use in this case are its waxy surface (very low co-efficient of friction) and its minute but perceptible cold flow.

In the new design, a spring-loaded follower sleeve compresses the Teflon bearing in a conventional packing gland, eliminating the necessity of lubricant as a sealing medium. Light oil or lubricant, however, can be applied to the shaft and will not harm its performance. Factory tests of this design without lubricant show no leakage under high pressure, and free rotation of the shaft under a torque of only 9.7 gram-inches. Many months of laboratory experiment with high pressure nitrogen did not disclose any leakage whatever in this design. More than a year's field testing by several major pipeline companies and oil companies (measuring gas at cycling plants) has demonstrated outstanding performances on various kinds of corrosive gases with entrained liquid.



MAGNESIUM

How about deep draws?

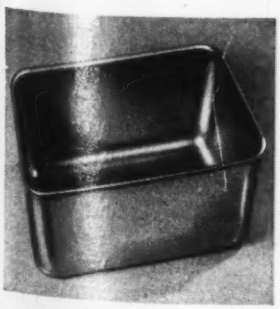
It's amazing what you can do in one draw with magnesium! Metal designers are usually surprised at the drawability of the material. As a matter of fact, the practice of hot forming magnesium permits deformations impossible in any other metal.

Generally speaking, magnesium alloys can be hot drawn in one operation to a depth equal to 80% reduction in blank size. This often eliminates the need for multiple stage dies, speeds up the operation, and reduces processing costs even though preheating of the sheet and dies is required. Hot forming greatly reduces spring-back problems.

Almost any press found in the ordinary press shop can be used to draw magnesium, although hydraulic presses are preferred when the draw is severe and controlled speeds are required. Dies are similar to those used on other metals.

For additional information on drawing or otherwise forming magnesium, call your nearest Dow sales office or write direct to Dept. MG-73.

8½ inch draw in one operation!



This radar container, 15 inches long by 10½ inches wide, was drawn to its full depth of 8½ inches in one draw from ⅛ inch magnesium stock.

Magnesium Division, Dept. MG-73

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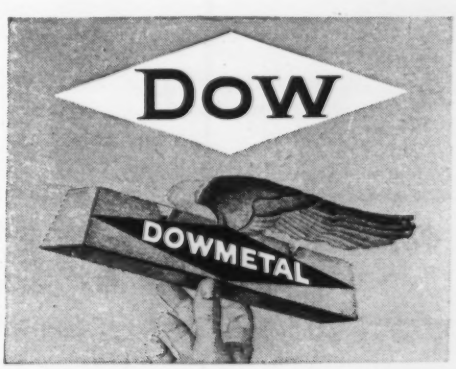
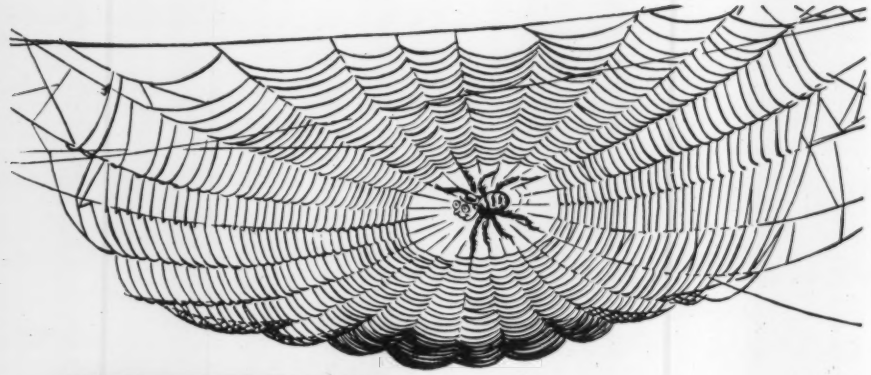




UNSOLVED:

How can a Spider spin this web in half an hour?

He's a traveling factory! Suppose we could duplicate this spider *man-size:* we'd require about 5 miles of cable for this web. What we'd make it of and how we'd erect it in 30 minutes is just part of the mystery!

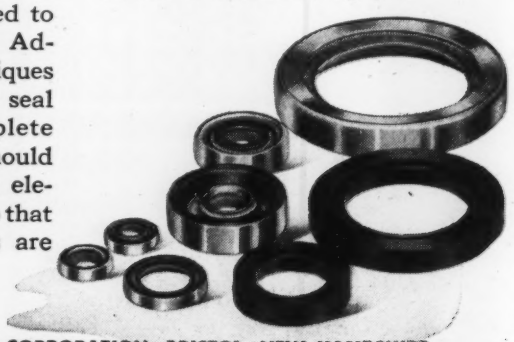
SOLVED:

How to make efficient Oil Seals with fewer metal parts

Today as never before, oil seals are being designed for specific jobs, and the art of fluid sealing has become a science.

Improved materials and techniques share this responsibility. Synthetic rubber and plastics are being adapted to more efficient sealing. Advanced moulding techniques have kept pace with oil seal design: today the complete seal emerges from the mould with metal and sealing element perfectly bonded, so that multiple metal housings are not required.

G&K-INTERNATIONAL has pioneered many of these advances to meet the needs of speed, material, lubricants, temperature, pressure, *space and assembly*. Making Oil Seals to seal your oil is our business. We can help you.



INTERNATIONAL PACKINGS CORPORATION, BRISTOL, NEW HAMPSHIRE
GRATON and KNIGHT COMPANY, WORCESTER, MASSACHUSETTS

GRAKONE OIL SEALS

IPC

100 YEARS OF SERVICE TO INDUSTRY

GRATON AND KNIGHT

Design Abstracts

(Continued from Page 167)

vantage in that, by a fairly simple and rapid process, it can form parts to close tolerances.

Although powder parts can be given a scratch brush or polished and lacquered finish, it is only recently that a plated finish has become practical. Research by several companies has produced methods of applying most commercial plated coatings.

From a paper entitled "Some Design Aspects of Metal-Powder Parts," presented at the ASME Annual Meeting in New York, November 26-December 1, 1950.

Railroad Motive Power

By A. H. CANDEE
Westinghouse Electric Corp.
East Pittsburgh, Pa.

RAILROAD motive power is undergoing a metamorphosis, with the steam locomotive being replaced rapidly in many countries by the more economical diesel electric locomotive. A large amount of money and of thinking is also being expended on other new types which hold promise of being even more economical than the diesel electric unit.

STEAM TURBINE LOCOMOTIVES: It is obvious that the number of axles which may be driven by mechanical drive (gears) from a single turbine is limited. For a high capacity locomotive, especially for freight work, it is desirable to drive at least six and preferably eight axles. These considerations led the Chesapeake and Ohio Railway to install three coal-burning steam-turbine electric locomotives in 1947. These locomotives, of Baldwin-Westinghouse design, use a boiler pressure of 300 psi and single 6000 - horsepower noncondensing steam-turbine driving generators. These supply electric power to eight traction motors, each geared to a driving axle. Although especially suitable for freight work, because of the number of driven axles, they were originally geared for and used in passenger service.

Work is now in progress on a new 4500 - horsepower noncondensing steam-turbine electric freight locomotive for the Norfolk and Western Railway. It will have a new water-tube boiler operating at a pressure of 600 psi and a steam temperature of

"We will sign it with our name"

Few things in life are as precious to a man as his name. He bestows it with pride on his heirs. He does not sign it lightly. To the man of integrity, his signature is not so much a means of identification as an evidence of good faith.

When the Jenkins brothers were satisfied they had made the best valve money could buy, they *signed* it with their name. Today, as for over three quarters of a century, that signature — forming, with the famous Diamond, the Jenkins trade mark — is more than a symbol of the maker's pride in his craftsmanship. It is the mark of a friend you can trust.

Jenkins Bros., 100 Park Avenue, New York 17. Jenkins Bros., Ltd., Montreal.

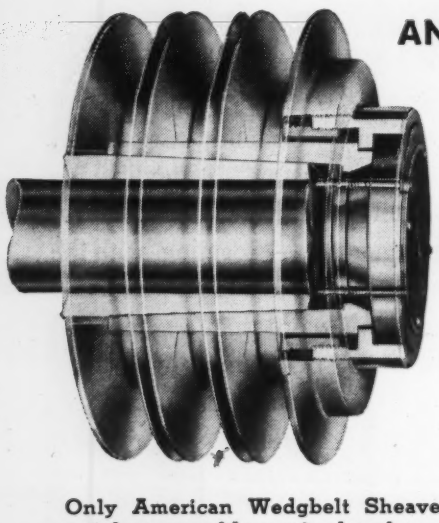
JENKINS
VALVES

Only AMERICAN WEDGBELT® SHEAVES give you the advantages of TAPER-BUSHED HUBS

ON BOTH

Multiple-Groove Fixed-Pitch Sheaves

AND



Multiple-Groove Adjustable-Diameter Sheaves

Only American Wedgbelt Sheaves give you the advantages of *quicker assembly, easier breakaway* yet *maximum clamping action* in *both* fixed-pitch *and* adjustable-diameter multiple-groove sheaves.

Assembly is quicker because of one-piece, accurately-machined bushings—breakaway is easier because of the exclusive "perfected taper" of American Wedgbelt bushings—maximum clamping action is assured because the bushings are *split all the way* through. In addition, precision manufacturing assures accurate, long-wearing grooves and balanced vibration-free operation.

Look to American as your source of supply for *all* V-belt drive products: Taper-bushed Standard Wedgbelt Sheaves, Double-Taper Adjustable-Diameter Wedgbelt Sheaves, F.H.P. Sheaves and F.H.P. and Multiple Wedgbelts. Mail the coupon below for full information on the complete line of American Wedgbelt Drives.

The American Pulley Company
4238 Wissahickon Avenue, Philadelphia 29, Pa.

Please send me information on American Wedgbelt Drives.

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____

900 F. Mechanical drafting will be employed, permitting the turbine to exhaust to approximately atmospheric pressure. The overall locomotive efficiency is expected to be such that the coal consumption will be approximately 50 per cent that of the conventional reciprocating steam locomotive.

Diesel Electric Most Popular

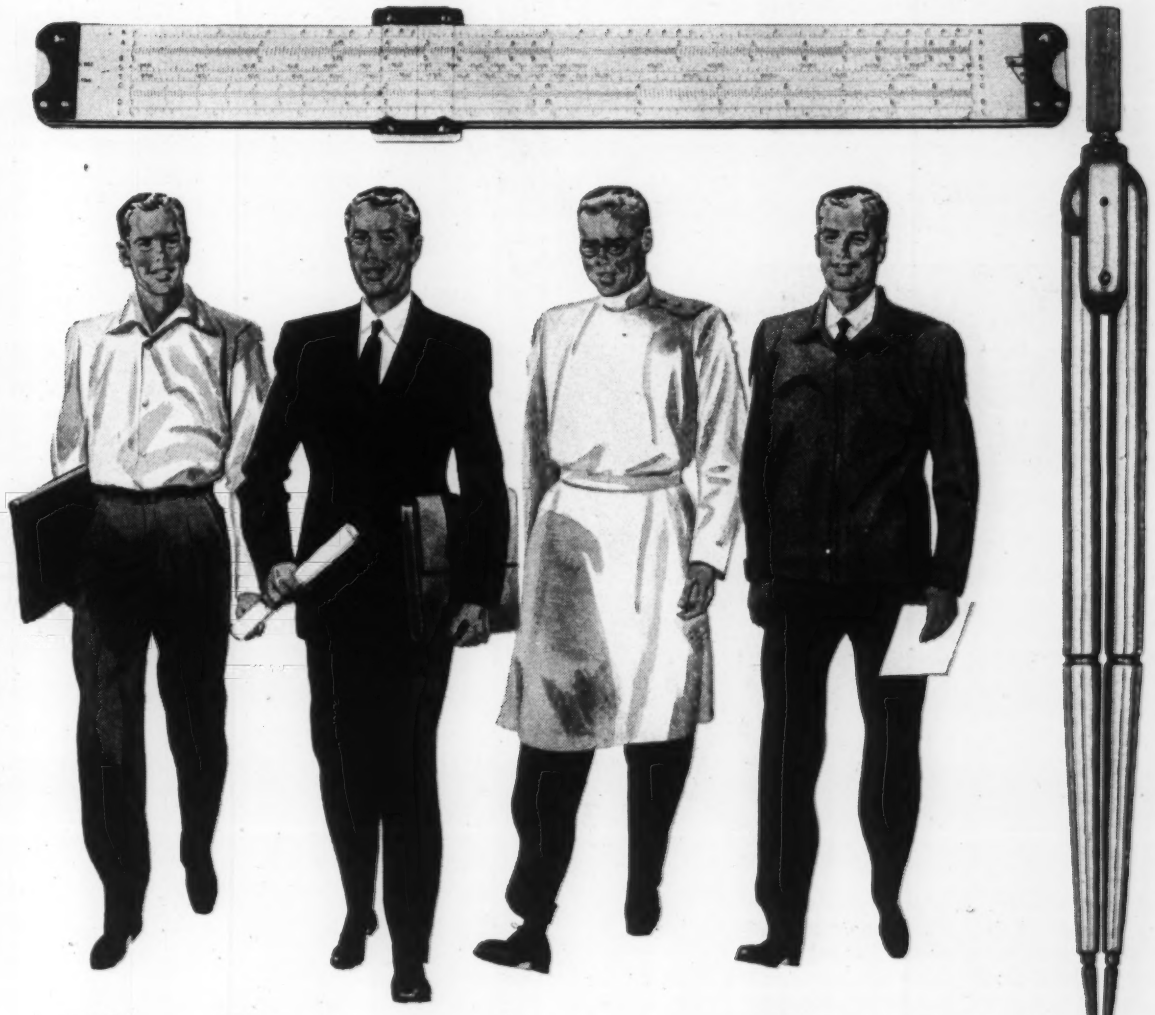
DIESEL ELECTRIC LOCOMOTIVES: Diesel electric switching locomotives are now accepted as being the most satisfactory and economical type of motive power for yard switching work. Diesel electric road freight and passenger locomotives are being applied in increasing numbers because of their economical performance and superior characteristics for hauling trains. Developments in this type of motive power consist primarily of improvement of details, such as up-rating of existing engines, improvements in electrical insulating materials, developments in lubrications and practices, simplification of locomotive auxiliaries, and standardization of locomotive subassemblies.

DIESEL RAILCAR: The Budd Company is now demonstrating a double truck railcar designed primarily for suburban service. This has two 275-hp, 1800-rpm diesel engines mounted under the car floor, each engine driving one axle of the adjacent truck through a fluid coupling while the car is accelerating and then by direct drive over the higher range of car speeds.

Trolley Systems Increasing in Favor

SYSTEM FED ELECTRIC LOCOMOTIVES: One important war-time development that may be considered an as improvement in equipment for electrification is the Ignitron. This member of the mercury-arc rectifier family was widely used during the war to convert alternating current to direct current for the production of aluminum. The Ignitron can be used for efficient conversion of power from multiphase power sources at commercial frequencies to direct current for application to trolley or third rail systems, and reduces the installation expense for such systems. However, developments during the past 18 months have destined the Ignitron to play a more important role than that of a wayside power conversion device—it has been promoted to a key position on the locomotive itself.

In addition to the fact that the Ignitron rectifier locomotive offers advantages in improved efficiencies, lowered repair expenses and reduced installation costs, the prospects for



The Expert Answer Team

For manufacturers of motor cars and trucks, tractors, farm implements, mining and road machinery, automotive equipment, aircraft, heavy and light machinery and other equipment.

Physicists, metallurgists, chemists and design engineers are engaged constantly on problems involving engineered rubber and plastic products... at the United States Rubber Company at Fort Wayne. The plant's main work is the manufacture of engineered rubber parts for original equipment makers only—to make their products more functional, more comfortable, more safe.

The "U. S." experts are at the service of manufacturers of all types of mechanical equipment with moving parts—such as motor cars, trucks and tractors. The "U. S." men have one of the most modern and complete laboratories in existence. At their fingertips are all the latest research and development facilities. Many of their instruments and tools are unique, some were designed by the very technicians who use them.

This United States Rubber Company laboratory at Fort Wayne and the skilled personnel are at your service. Try them ... for even your most hopeless problems.

U.S.RUBBER
SERVING THROUGH SCIENCE

UNITED STATES RUBBER COMPANY

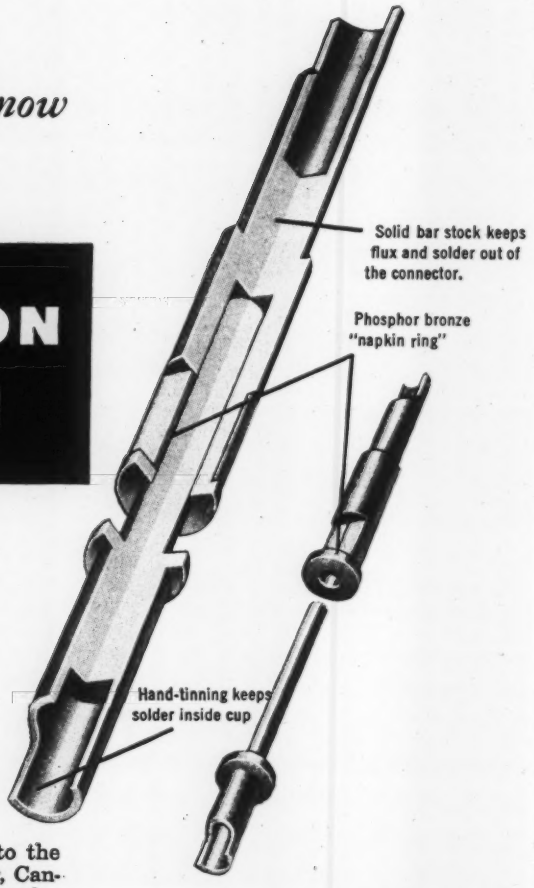
FORT WAYNE, INDIANA

ENGINEERED RUBBER PRODUCTS

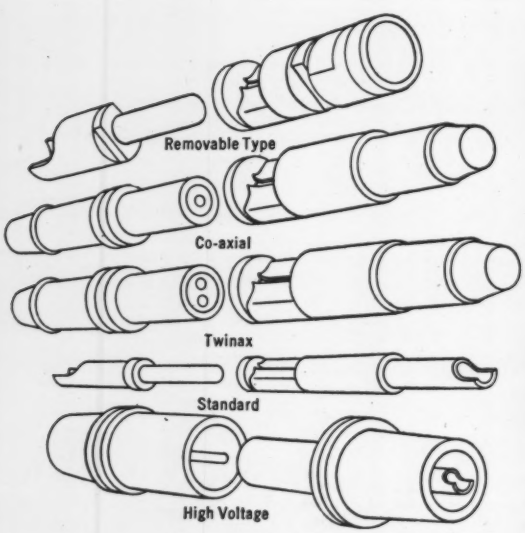
Here's why those in the know demand–

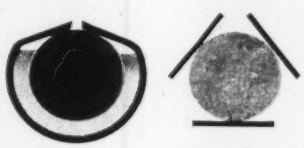
CANNON PLUGS

superior contact design


Solid bar stock keeps flux and solder out of the connector.
Phosphor bronze "napkin ring"
Hand-tinning keeps solder inside cup

Because the contact is the key to the success of any electric connector, Cannon has always applied the highest order of skill and care to this all-important detail. Cannon pin and socket contacts are all precision machined from solid bar stock. Silver or gold plating maintains high conductivity after years of constant use. Phosphor bronze "napkin ring" of the socket keeps pressure on large areas of heavy metal, preventing current loss. There are no thin metal tangent contact points in Cannon contacts. (See below). Solder cups are carefully tinned by hand to keep the solder inside the cup. Cannon socket contacts are full floating to assure perfect alignment. You'll find these design features throughout the great variety of precision contacts used in all Cannon connectors. For real value demand Cannon.





Cannon design (above left) makes contact on large, heavy metal surfaces. Current is not carried through spring section. In Cannon Connectors there are no thin metal tangent contact points, like the design shown at right.

CANNON ELECTRIC

Since 1915

LOS ANGELES 31, CALIFORNIA
REPRESENTATIVES IN PRINCIPAL CITIES

In Canada & British Empire: Cannon Electric Co., Ltd., Toronto 13, Ontario. World Export (Excepting British Empire): Frazar & Hansen, 301 Clay St., San Francisco, California.

trolley electrification are better than they have been for some time. Whereas traffic density has been considered the criterion for determining the economies of electrification, the persistent increases in wage rates have given rise to serious thought as to ways and means of reducing the labor content of railroad operating costs. In this respect, the system-fed electric locomotive offers the greatest relief, since the labor required for its operation and repair is lower than for any other type. Moreover, power costs have been stable and in some cases have had a downward trend, while both liquid and solid fuel prices have been advancing. It is probable that the future will disclose a rise in the number of trolley electrification projects.

GAS TURBINE ELECTRIC LOCOMOTIVES: The Westinghouse Electric Corp. has constructed a single unit, 4000-horsepower gas-turbine electric locomotive which weighs 240 tons and is mounted on four 2-axle swivel trucks with traction motors driving all axles. Power is generated by two 2000-horsepower (net for propulsion) turbine generator sets mounted opposite each other in the lomotive with a center aisle. Each turbine rotates at a maximum of 8750 rpm, uses liquid fuels, and drives electric generating equipment through a reduction gear which is interposed between the rotary compressor of the prime mover and the main generators.

Gas Turbine Not Yet Proven

The gas turbine is in its infancy and a great many of its operating characteristics are unknown. Life of blades, of combustors, and of nozzles in normal railway operation are undetermined; yet, short life of these parts may easily cause repair costs to be high. Warping or distortion of parts due to rapid temperature changes or to shocks incident to locomotive operation can only be gaged by extensive service on rails. Some factors are known, such as wide variations in horsepower output due to atmospheric temperature changes and elevation above sea level, but in general there is a great amount of testing to be run out before the railroads can accept this type of prime mover as a reliable and economical member of the motive power family. Westinghouse engineers plan to use liquid fuels during this period of development, but are experimenting with the preparation of solid fuels.

From a paper entitled "Revolution in Railroad Motive Power," presented before the Western Society of Engineers in Chicago, October 9, 1950.

deep-drawn shapes

with improved

STRENGTH-WEIGHT RATIOS

Produced by the

Scaife

reverse-draw process

Starting with a circular sheet of steel—
a cup is formed by a conventional drawing operation.
A continuation of this pressing operation turns the cup "inside out" without removing it from the dies—
completing—in a single stroke—a deep-drawn shape having remarkably uniform wall thickness.

Inherent in this process is the ability to maintain uniform wall thickness throughout the entire length of the draw (max. variation within mill tolerance of the material). This means no thin, weak areas, or thick, heavy sections to add unnecessary weight. Physical properties of the metal are improved by the processing.

Scaife deep-drawn shapes can be made in circular and non-circular cross-section. For pressure vessels, containers and tanks of various types, Scaife Reverse-Drawn Shapes provide many advantages. We will be glad to furnish specific information on any items in which you may be interested.

SCAIFE COMPANY

OAKMONT (Pittsburgh District), Pa.

SELF-ALIGNING HI-LOAD

Pat. No. 2,462,138
Further Patents Pending

SPHERICAL BEARINGS by HALFCO

Bore Sizes from 3/16th to 3 Inches

HAVE BEEN USED IN ALL TYPES OF INDUSTRY SINCE 1944 . . . *If your application or problem involves HI-LOAD, MISALIGNMENT, VIBRATION or SHOCK, a HALFCO BEARING is your answer.*

FOR MAXIMUM LOAD REQUIREMENTS, HALFCO BEARINGS ARE NOW AVAILABLE WITH 4130 "CHROME-MOLLY" STEEL OUTER RACE, HEAT TREATED . . . *DESIGNED FOR LUBRICATION AT I.D. AND O.D. OF INNER RACE.*

HALFCO BEARINGS, formerly manufactured by Adel Precision Products Co., are now manufactured exclusively by HALFCO BEARING DIVISION, AETNA STEEL PRODUCTS CORPORATION.

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Plant One 812 So. Flower St., Burbank, Calif.

Plant Two 315 Asylum St., Bridgeport, Conn.

DON'T GO HALFWAY!! GO HALFCO!!

NEWS OF MANUFACTURERS

Wright Aeronautical Corp., Main and Passaic Sts., Wood-Ridge, N. J., is seeking suitable subcontractors for the following items: hardened and ground parts; fabricated stainless-steel sheet (press and certified welding equipment required); gears; screw machine products; aluminum castings, raw and finished; magnesium castings, raw and finished; steel castings, raw and finished; aluminum forgings, raw and finished; controls and accessories; and engine subassemblies. Wright manufactures both piston and jet engines.

♦

Buick Motor Division, General Motors Corp., has been awarded a $65,000,000 prime contract to build tank transmissions for the government. The contract was awarded by the Ordnance Tank Automotive Center, Detroit, Mich. The transmission is a torque converter type employing the same principle as Buick's Dynaflow drive. All forging, machining and assembly of the transmission will be done at Buick's Flint, Mich., plant. Part of the work will be done in the new 170,000 sq ft addition being built onto the Buick foundry. The transmissions will be assembled in the factory now housing car shipping operations.

♦

General Electric Co. in 1950 broke its all-time record for production of large turbine generators. The company's new $30,000,000 turbine plant at Schenectady, N. Y., in its first full year of operation, produced units with a combined capacity of 2,866,000 kilowatts. Almost the entire 1950 output went to utilities.

♦

Eutectic Welding Alloys Corp., 40 Worth St., N. Y., is celebrating its tenth anniversary. One of the feature events of this year will be the occupancy of the new Engineering and General Offices building expected shortly.

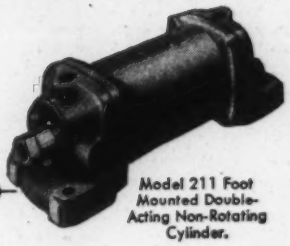
♦

Philips Laboratories Inc., N. Y., ranked seventh in the 1950 U. S. patent listing. Over 250 Philips-originated U.S. patents were issued during 1950 to the Hartford National Bank and Trust Co. as trustee, according

RIVETT Furnishes—

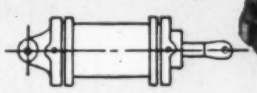
a Complete Power Package

Rivett can furnish the correct valve and cylinder for any hydraulic circuit. There are nearly 300 primary models in the standard Rivett line, each available in a variety of sizes and types. Because of the simplicity of Rivett design, variations can be made to meet any unique situation.

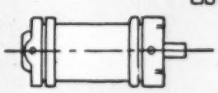


Model 211 Foot Mounted Double-Acting Non-Rotating Cylinder.

Seven Standard Mountings



Clevis



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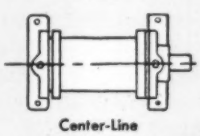
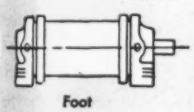
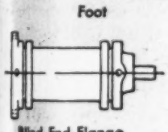


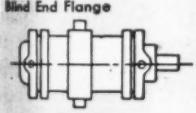
Center-Line



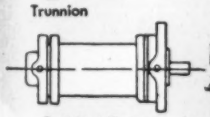
Foot



Blind End Flange



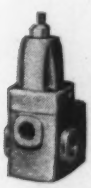
Trunnion



Rod End Flange

CYLINDERS

Offered in pressure ranges of 300 P.S.I. maximum, and 1500 P.S.I. maximum oil services. 3000 P.S.I. maximum service and higher pressure ranges furnished on application. Available in ten bore diameters, in strokes up to 96″, with standard and 2:1 differential over-size rod; and with cushioning rod end, blind end or both. Special models supplied.



Model 8832 Sequence Valve

Model 8630 Cam Operated Flow Control Valve

Model 7200-1 Oil Pilot Operated Valve

Model 5605 Solenoid Pilot Operated Four-Way Valve

Model 5805 Oil Pressure Operated Four-Way Valve

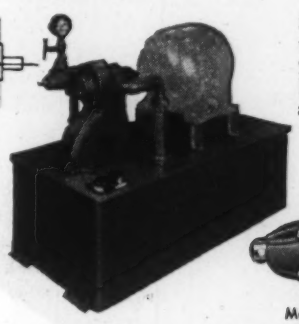
VALVES

Designed for oil service pressures up to 1500 P.S.I., and furnished for 3000 P.S.I. in certain models. Available in standard, spring-return, spring-centered, and ball detent action; five piston designs: hand, foot, cam, solenoid, oil pressure, and air pressure operated; 1/4″, 3/8″, 1/2″, 3/4″, 1″, 1-1/4″ and 1-1/2″ sizes.

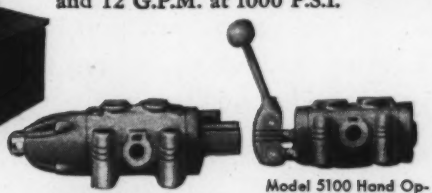
POWER UNITS

Series 9100 single pump, in 5 tank sizes. Capacities, .4 G.P.M. to 40 G.P.M. at 1000 P.S.I. Series 9200 double pumps in 5 tank sizes. Delivery combinations, 3 G.P.M. and .4 G.P.M. to 40 G.P.M. and 12 G.P.M. at 1000 P.S.I.

Model 5900 Air Pressure Operated Four-Way Valve



Send for Rivett Catalog Sections 104 and 202



Model 5310 Cam Operated Four-Way Valve

Model 5100 Hand Operated Four-Way Valve

Model 5500 Double Solenoid Operated Four-Way Valve

RIVETT DEALERS EXPERIENCED IN HYDRAULIC APPLICATION

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Philadelphia, Pa.—The Battersby Co., 3701 N. Broad St.
Boston, Mass.—L. W. Sheehy, 1104 Park Sq. Bldg.
Baltimore, Md.—Colliflower Equip. Co., 516 No. Loudon
Pittsburgh, Pa.—F. R. Magill Co., 44 McKnight St.
Cleveland, Ohio—Garco Machy. Co., 7702 Carnegie
Detroit, Mich.—Fors Sales Co., 2832 E. Grand Blvd.
Flint, Mich.—Shively Sales Company, 719 E. 2nd Ave.
Chicago and Milwaukee—MacMillin Engineering Corp., 6806 North Clark St., Chicago 26, Ill.
St. Louis, Mo.—William Scheer Co., 6376 Clayton Rd.
Dayton, Ohio—Seifreat-Elstad Machy., P.O. Box 322
Cincinnati, Ohio—Seifreat-Elstad Machy., P.O. Box 344
Columbus, Ohio—Seifreat-Elstad Machy., P.O. Box 922
Columbus, Ga.—Bunn H. Martin, P. O. Box 350
Minneapolis, Minn.—Anderson Machine Tool Co., 2641 University Ave., St. Paul 4, Minnesota
Denver, Col.—Iver J. Esbenson Co., 1249 Calif. St.
Los Angeles, Calif.—Haskel Engineering & Supply Co., 721 West Broadway, Glendale, California
San Francisco, Calif.—Ditzen Engineering and Sales, 600 16th St., Oakland 12, Calif.
Portland, Oregon—Hydraulic Power Equipment Co., 2316 N. W. Savier St.
Seattle, Wash.—Pump Engineering Co., 1331 3rd Ave. Bldg.
Canada—Duncan Machinery Co., Ltd., 1922 Wyandotte St. East, Windsor, Ontario; 371 Bay St., Toronto

Dept. MD 3, RIVETT LATHE & GRINDER, Inc., Brighton 35, Boston, Massachusetts

WHEN YOU APPLY HYDRAULIC OR AIR POWER *Plan with* **RIVETT**

Air and Hydraulic Valves and Cylinders, Hydraulic Power Units.

It's always SPRING TIME at NO. 2 JOHN ST.

In fact, we at American-Fort Pitt Spring have been making coil springs—all kinds, hot or cold wound—spring, summer, fall and winter, for more than sixty years.

Over the years our engineers have worked on almost every conceivable type of spring problem. In many instances their recommendations have helped cut production costs and improve product performance. In every instance the springs we furnish are delivered precisely as specified and in conformity with highest standards.

When you need springs, the No. 1 place to think of is No. 2 John Street, McKees Rocks, Pa., home of the AMERICAN-FORT PITT SPRING Division of H. K. Porter Company, Inc.

AMERICAN-FORT PITT SPRINGS

to a patent analysis made by the Technical Survey, Newark, N. J. This survey lists the six leaders as: **General Electric, International Telephone and Telegraph, Radio Corp. of America, Westinghouse, Du Pont,** and **Standard Oil.**

♦

Revere Copper & Brass Inc., New York, N. Y., will be joined by many in the celebration of its sesquicentennial. Paul Revere, famed as a patriot for his ride of 1775, gained a less-known claim to immortality by turning out copper sheets for the first time in the United States. It was during 1801 that he founded the copper-fabricating industry.

♦

R. M. Hollingshead Corp., Camden, N. J., has merged its Cocoon engineering and industrial-aviation divisions. Sale of Whiz Cocoon will come under the marketing policies of the latter division. Cocoon is the vinyl plastic spray film developed by Hollingshead to "mothball" much war material for outdoor storage after World War II.

♦

Worthington Pump and Machinery Corp., Harrison, N. J., has made a division of a former subsidiary, Worthington-Gamon Meter Co., Newark, N. J. The new division will continue to manufacture liquid meters at the Newark plant.

♦

Sintercast Corp. of America has moved its office, laboratory and production facilities from New York City to larger quarters in Yonkers, N. Y. Until its recent acquisition of the business and equipment of the Wright Carbide Co., East Orange, N. J., Sintercast was primarily a research and development organization. Activities are now divided into two specialized categories: research into and development of new powder-metallurgy techniques and alloys; production of standard and special-purpose powder-metal parts.

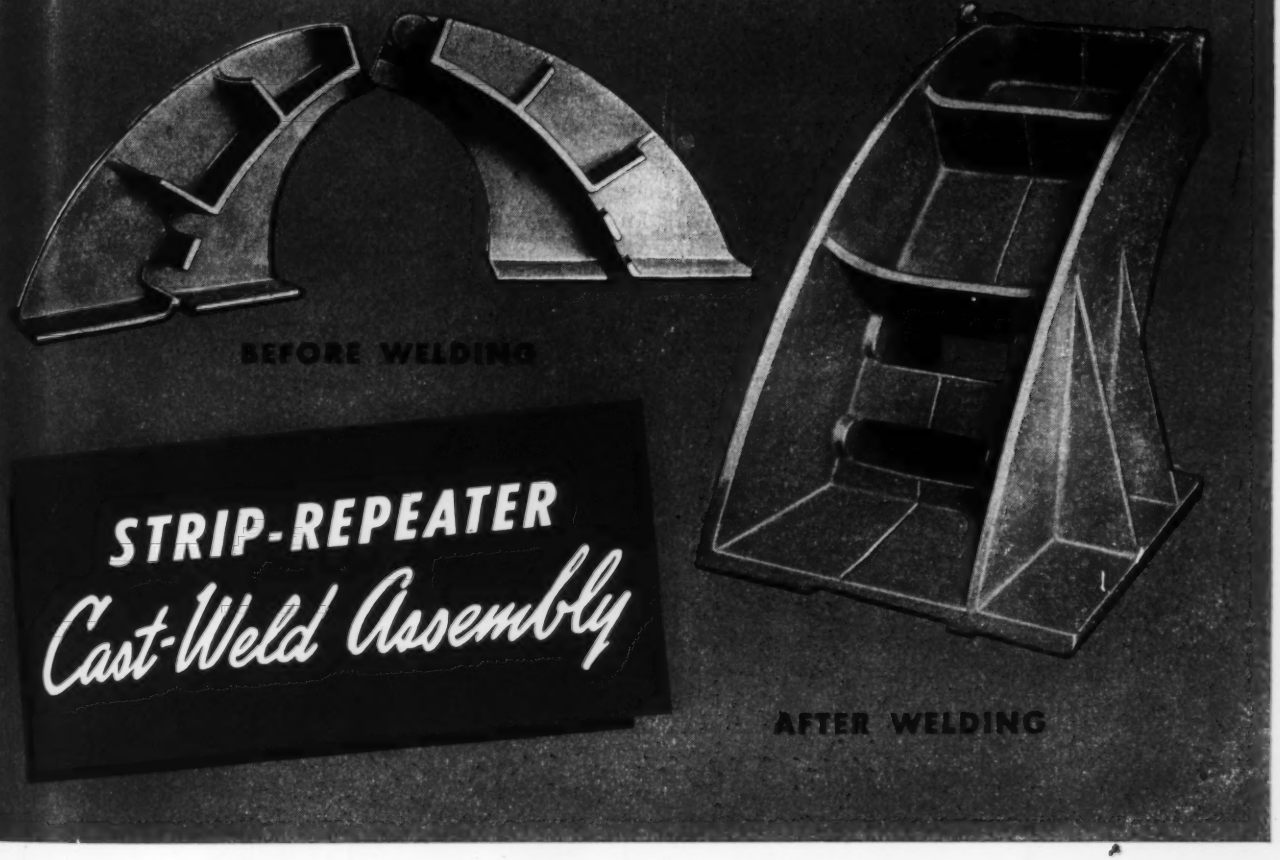
♦

Ohio Electric Mfg. Co., Cleveland, O., has purchased all tools, patents and rights to manufacture the Taylor & Fenn line of drilling machines. Tools, dies and fixtures are being transferred to the Cleveland plant.

♦

Worthington Pump and Machinery Co. has acquired the plant and equipment of the National Transit Pump and Machine Corp. The plant covers 500,000 sq ft and includes iron, steel and brass foundry, pattern and forge shop, machine shops and assembly

PRODUCT DESIGN STUDIES • NO. 17



STRIP-REPEATER
Cast-Weld Assembly

About 10% Saving Effected By Using Cast-Weld Construction

Four of these ponderous strip repeaters—each weighing about 2½ tons—were required for a Chilean strip mill. To produce them as single steel castings would have been difficult and uneconomical.

Redesign to two steel castings—to be joined by welding—eliminated all cores, reduced pattern cost and resulted in an estimated saving of 10% over cost as a complete fabrication.

* * *

Conversion of some of your parts to *foundry engineered* cast-weld assemblies and *foundry engineered* steel castings—through close cooperation of your engineering department and the steel foundry—may result in more production, of better quality, in less time and with less metal.

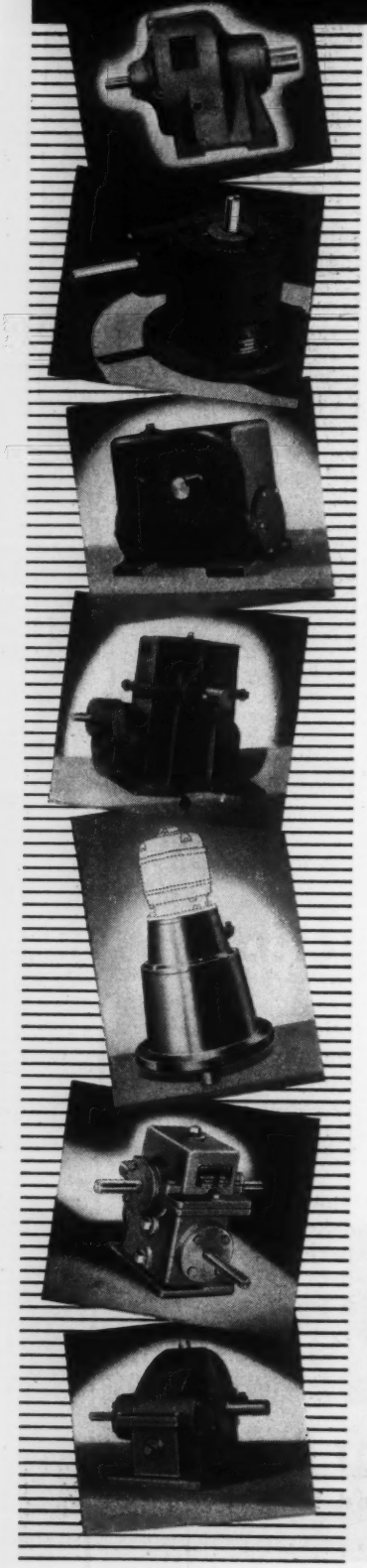
Your steel foundry representative will welcome an opportunity to make available to you his company's long experience, *plus* the full results of the development and research program carried on by the Steel Founders' Society of America.

STEEL FOUNDERS' SOCIETY OF AMERICA
920 Midland Building Cleveland 15, Ohio

Design and Build With Steel Castings

Shorten the interval between design and assembly line with

WINSMITH Standardization



Huge military and domestic needs place increased emphasis on design speed-ups and production simplification.

This calls for maximum standardization. One way to achieve it, where power transmission problems are involved, is with Winsmith speed reducers. For, no matter how individual the purpose, how specialized the function, how complex the design and production problems, most requirements can be served with standardized Winsmith reducers.

With industry's widest range of standard designs and sizes from fractional to 85 H.P., Winsmith can meet your normal and special demands . . . can help you shorten the interval between machine design and assembly line.

And a Winsmith power transmission engineer in your locality is available for consultation.

DESCRIPTIVE FOLDER, "Save through Standardization," will aid in your selection. Write.

WINFIELD H. SMITH CORPORATION

16 Elton St.

Springville (Erie County), N. Y.

50th WINSMITH SPEED REDUCERS 1901-1951 ANNIVERSARY

WINSMITH SPEED REDUCERS

floor, test facilities, power house, steel fabricating shop and administration building. Miscellaneous overflow from Worthington's other factories will be diverted to the plant which is located in Oil City, Pa. Worthington plans to continue to furnish repair and spare parts for the products of National Transit Pump now in the field. Studies of the plant facilities with relation to Worthington products are still in progress.

♦

Greer Hydraulics Inc. is building a new plant adjoining its existing facilities at 454 Eighteenth St., Brooklyn, N. Y. The new plant will provide an additional 40,000 sq ft of engineering, manufacturing and laboratory area and will double the present productive capacity of the company. Operation in the new plant is expected by May 15, 1951.

♦

A. Kimball Co., 309 West Broadway, N. Y., in its seventy-fifth year, has created a special department designed to aid the defense effort. The new department is devoted to supplying service and advice in connection with inventory controls, routing, parts identification, etc., through the use of tags, pressure sensitive, heat sealed and gummed labels, and pressure sensitive tape. A special circular "Labeling for Defense" has been prepared to advance the program.

♦

S. G. Frantz Co. Inc. has transferred its sales and manufacturing facilities from New York City to a new plant on the outskirts of Trenton, N. J. Frantz manufactures a magnetic separator for the extraction of iron particles from suspension in liquids or from granular materials.

♦

J. M. Ney Co., Hartford, Conn., manufacturer of precious metal alloys and component parts, has acquired a new plant in East Hartford, where production facilities are being expanded.

♦

Minnesota Mining & Mfg. Co., St. Paul, Minn., has purchased a 114-acre tract in southwest Chicago as a step in a long range industrial expansion program. Initial phase of the program is a $3,000,000 plant now under construction for the Mid-States Gummed Paper Co., a subsidiary of MMM. The one-story plant has a floor area of 265,000 sq ft and is scheduled for complete occupancy by Jan. 1, 1952. Mid-States manu-

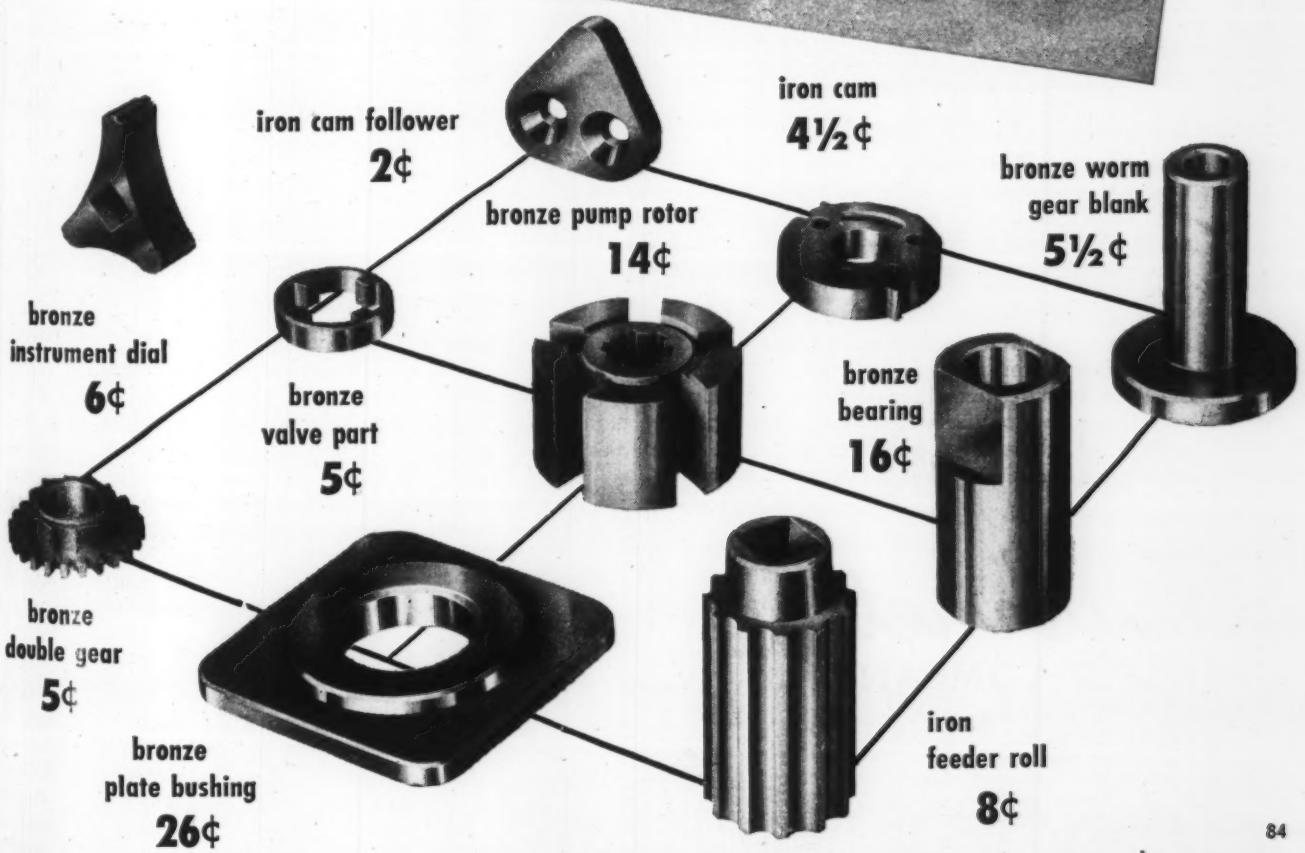
save metal save man-hours save money with GRAMIX® parts

By using Gramix parts, die-pressed of powdered metal mixtures, in place of machined parts in your products, you can make three important savings—savings that are becoming more vital with every day that passes.

GRAMIX PARTS SAVE METAL. They are made with minimum scrap and waste . . . pound-for-pound more pieces can be produced from Gramix than can be obtained from solid or bar stock that is in tight supply today.

GRAMIX PARTS SAVE MAN-HOURS AND MACHINING TIME because, in one operation, Gramix parts are die-pressed to within .0005" on all surfaces . . . the machining time saved can be made available for defense weapon production.

AND, GRAMIX PARTS SAVE MONEY because in quantity lots they can be produced at considerable less cost than identical machined parts. Then too, Gramix parts are oil-impregnated for self-lubrication thus eliminating the need for servicing. Add up the advantages and you'll see why it'll pay you to go to Gramix . . . the leader in the powdered metal field. Write us for the full story.



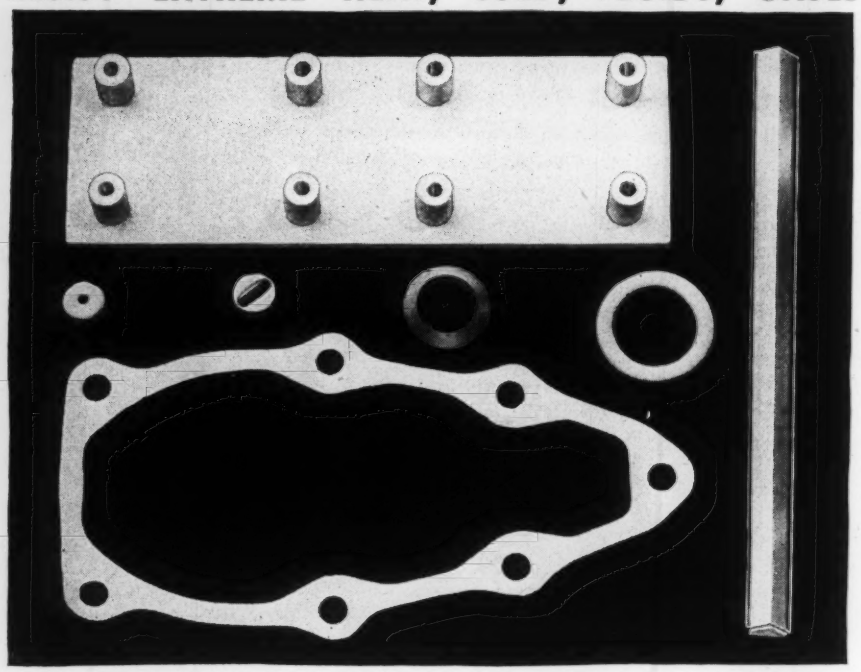
84

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

SILICONE RUBBER Parts

RESIST EXTREME HEAT, COLD, FLUIDS, GASES



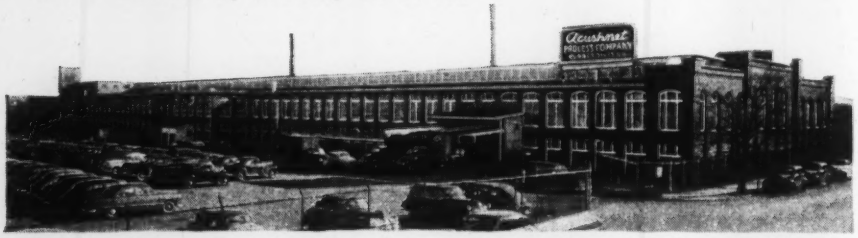
Silicone rubber is a solution to problems involving rubbery properties at abnormally high and low operating temperatures. Under these conditions it performs successfully beyond the scope of any known rubber or rubber-like materials, and meets the requirements of extreme temperature applications in the aviation, automotive, electrical, refrigeration and original equipment manufacturing industries.

At extreme temperatures −100°F to +500°F Silicone rubber parts remain resilient, with improved compression set. General qualities include; excellent stability after long exposure to ultraviolet rays, prolonged weathering, fungus growth, many oils and a variety of chemicals; excellent dielectric properties, and water repellency; stainless; odorless; bonds to metal.

Seals, gaskets, O-rings, packings, diaphragms and numerous parts can be produced from Silicone stocks.

Send for Rubber Handbook on your company letterhead

Acushnet
PROCESS COMPANY
New Bedford, Mass., U. S. A.



Address all communications to 762 Belleville Ave., New Bedford, Mass.

factures gummed paper and cloth tapes and labels which add to the line of MMM's Scotch tapes and other pressure sensitive adhesives, and Scotchlite reflective sheeting, coated abrasives, electrical and sound recording tapes, chemicals, and other products.

♦

Sealol Corp., Providence, R. I., has formed a subsidiary, Sealol Mfg. Co., in Keene, N. H. Anticipated increase in demand for the Sealol mechanical seals for rotating shafts prompted the formation of the new company.

♦

Fort Die Casting Corp. of Detroit has transferred its complete operations to a new plant at Marysville, Mich. Greatly increased and improved production facilities of the 100,000 sq ft plant will be used to meet the increased production requirements of aluminum, zinc and lead die castings which the company manufactures by contract.

♦

Delco Products Division, General Motors Corp., has produced a 16-mm motion picture entitled "Motors on Parade." The film has a two-fold purpose: to illustrate the importance of the electric motor on the domestic and industrial scenes and to show how electric motors are made on a mass production basis. Sound, black-and-white with a running time of 26 minutes, the film can be obtained for group showing without charge from Public Relations Department, Delco Products Division, General Motors Corp., 329 East First St., Dayton 1, O.

♦

Stephens-Adamson Mfg. Co. this year marks its fiftieth anniversary in the production of materials handling equipment. Beginning in a single 80 by 120-ft building at Aurora, Ill., June, 1901, the company today occupies a 13-acre plot with 230,000 sq ft of plant space. Branch plants are located at Los Angeles, Calif., and Belleville, Ontario, Canada.

♦

Bendix Aviation Corp. has purchased the Ford Motor Co. plant at Hamilton, O., for the production of aircraft parts and accessories for the armed services. The plant, which was used by Ford until a few months ago for stamping operations, represents the second major step taken by Bendix in recent weeks. The corporation previously acquired the plant and facilities of Victor Ani-

(*Continued on Page 221*)

(*Continued from Page* 218)

matograph Corp., Davenport, Ia. As with the Iowa plant, the Hamilton factory will operate as a division of Bendix and will be known as the Hamilton division. This latest acquisition increases to 18 the number of Bendix divisions, exclusive of subsidiaries.

♦

Bigelow-Sanford Carpet Co. has established a new division for the handling of defense orders. The Defense Contracts division will seek, evaluate and contract for defense business in blanket and cotton duck manufacturing, machine tool production, engineering development and research. During World War II, Bigelow converted to such products as parts for torpedoes and periscopes, radar equipment, bullet making machines, and others.

♦

Cummins-Chicago Corp. is the new name for the Cummins Business Machines Corp. Both internal growth and external expansion indicated the desirability of a corporate title more in keeping with the company's enlarged activities in the fields of perforating machines and electric portable tools.

♦

Waterbury Farrel Foundry and Machine Co., Waterbury, Conn., is observing its 100th anniversary. To commemorate the centennial, the manufacturer of metal-working machinery has issued an anniversary booklet entitled "100 Years Ago and Now" which gives a detailed history of the company. Copies of the booklet can be obtained free of charge by directing company-letterhead requests to the company.

♦

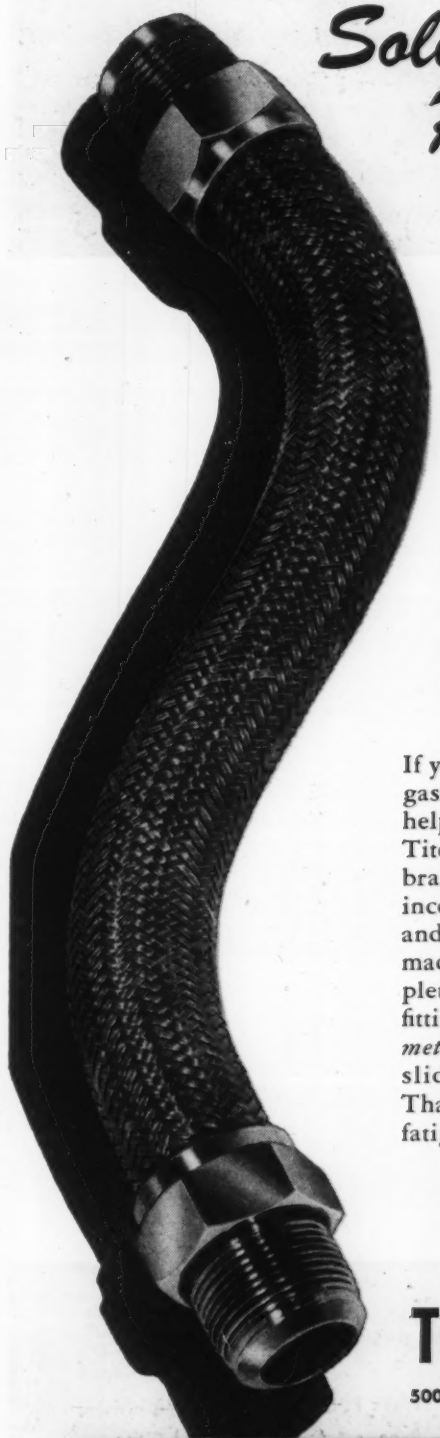
Dow Chemical Co. is erecting a new Hypersorber unit at its Midland, Mich., plant. Purpose of the unit is to separate light carbon gases for ethylene recovery. Because of its size, the Hypersorber was built in two sections which were transported from the Foster-Wheeler Corp., Carteret, N. J., the fabricator, to Midland. The Austin Co. is in charge of the construction.

♦

Reynolds Metals Co., Richmond, Va., is building an $80,000,000 aluminum reduction plant in the Corpus Christi area. The new plant will have the capacity to produce 150,000,000 pounds of aluminum pig annually. Good shipping facilities from Jamaica, where Reynolds has extensive

Titeflex

The ALL-METAL Flexible Tubing



Solves all these Problems **for you:**

VIBRATION
EXPANSION
CONTRACTION
MISALIGNMENT
FLEXING
PRESSURE
VACUUM
TEMPERATURE
CORROSION

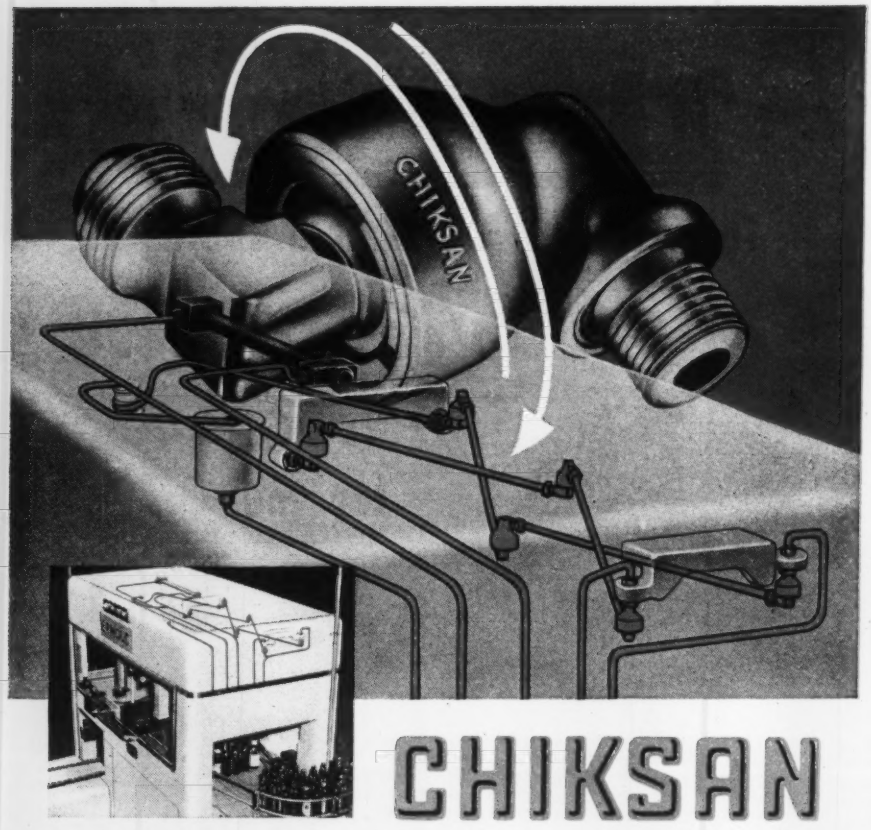
If you use tubing to convey liquids, gases or semi-solids, Titeflex can help you do it better, at less cost. Titeflex flexible tubing is made in brass, bronze, stainless, monel and inconel, to fill most heat, pressure and corrosion requirements. It's made in a full range of sizes, complete with any required types of fittings. In addition, Titeflex is *all-metal,* does not depend on packed sliding joints for its flexibility. That's why it is more resistant to fatigue . . . why it *lasts longer.*

Write us for catalog outlining Titeflex advantages in full.

Titeflex, Inc.

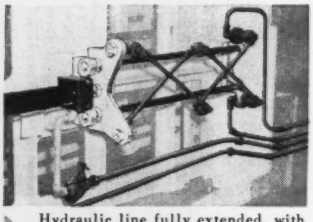
500 Frelinghuysen Ave., Newark 5, N. J.

TITEFLEX ALL-METAL FLEXIBLE TUBING STAYS TIGHT WHEN THE GOING IS TOUGH.

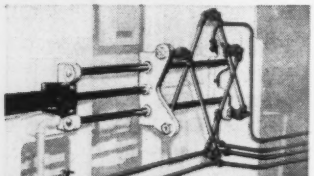


CHIKSAN

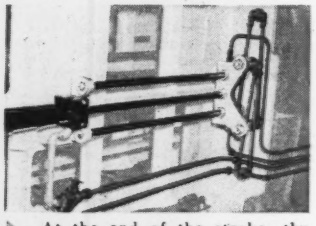
Hydraulic Swivel Joints help to simplify design



Hydraulic line fully extended, with turning movement taking place with CHIKSAN Swivel Joints.



As the Unpacker Head travels back and forth, the hydraulic line folds and unfolds automatically.



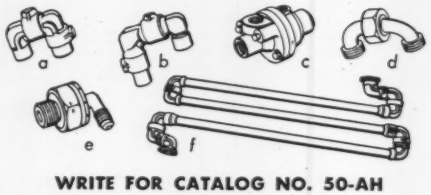
At the end of the stroke, the hydraulic line requires sharp bends which are possible only by using CHIKSAN Swivel Joints.

With CHIKSAN Hydraulic Swivel Joints you can design and build flexible hydraulic lines to handle pressures to 3,000 psi . . . and thereby gain advantages not obtainable by any other method. A typical example is the *Ermold Automatic Case Unpacker.*

CHIKSAN Hydraulic Swivel Joints make possible sharp bends, thus permitting installations where space is limited. They eliminate drag and snag. In addition, you get uniform low operating torque, strength and safety under all conditions. All-metal tubing assures longer life.

There are 5 Basic Types of CHIKSAN Swivel Joints — a Type for every purpose. CHIKSAN Engineers will gladly cooperate with you in selecting the correct Type . . . either standard or of special design . . . for your specific requirements.

(a) Basic Type Swivel Joints — for pressures from 125 psi. to 15,000 psi. (b) High Temperature Swivel Joints for temperatures to 500° F., working pressures to 700 psi. (c) Rotating Joints for 150-lb. steam, brine, etc. For hot and cold rolls, tumblers, platens, etc. (d) Sanitary Swivel Joints for food processing, fruit juices, dairies, etc. (e) Hydraulic Swivel Joints for pressures to 3,000 psi. For aircraft, industrial and armored equipment. (f) Flexible Lines, designed and fabricated to meet specific requirements.



WRITE FOR CATALOG NO. 50-AH

Representatives in Principal Cities

CHIKSAN COMPANY AND SUBSIDIARY COMPANIES
NEWARK 2, N. J. **BREA, CALIFORNIA** CHICAGO 3, ILL.
CHIKSAN EXPORT COMPANY, 155 WASHINGTON ST., NEWARK, N. J.
WELL EQUIPMENT MFG. CORP., HOUSTON 1, TEXAS

BALL-BEARING SWIVEL JOINTS FOR ALL PURPOSES

CHIKSAN TRADE MARK REG.

bauxite reserves mined by its subsidiary, Reynolds Jamaica Mines Ltd., was one of the principal reasons for selection of the site. The plant is expected to be in operation by the end of the year.

♦

Barrett-Cravens Co., Chicago 9, Ill., manufacturer of floor-level materials handling equipment such as light-duty single-stroke hand lift trucks and high-lift electric-fork trucks, has merged with the Crescent Truck Co., Lebanon, Pa. Crescent will be operated as a division of Barrett.

♦

Parker Stamp Works Inc., Hartford, Conn., has purchased the entire business of the Schoder & Lombard Stamp & Die Co., New York City. Schoder manufactures steel stamps, dies, plastic molds, and allied products.

♦

Hauser Machine Tool Corp., Manhasset, N. Y., formed an affiliate company, **Carl Hirschmann Co.** The Carl Hirschmann Co. becomes the exclusive U. S. agent for a number of Swiss precision tool manufacturers among whom are included: Tornos Works Ltd.; Schaublin, S.A.; Lambert, S.A.; Safag, S.A.; and Agathon Ltd. Hauser Machine Tool Corp. is the exclusive agent for Henri Hauser Ltd.

♦

Allis-Chalmers Mfg. Co., Milwaukee, Wis., has announced that all physical assets of Canadian Allis-Chalmers Ltd. have been purchased by a new wholly owned subsidiary, Canadian Allis-Chalmers (1951) Ltd. The Canadian firm will continue the production of heavy machinery for the Canadian market.

♦

United States Rubber Co. has signed a contract with the Corps of Engineers, U. S. Army, to reactivate the huge Kankakee, Ill., ordnance works for the manufacture of high explosives. Work of reactivation has started under the supervision of the company's Naugatuck chemical division. The Kankakee works is one of the largest in the nation. It was completed in September 1941 and produced more than 1.4 billion pounds of explosives during World War II.

♦

Caterpillar Tractor Co. has entered 1951 with a $42,000,000 contract from the Corps of Engineers, U. S. Army. The contract calls for the larger size standard tractors manufactured by

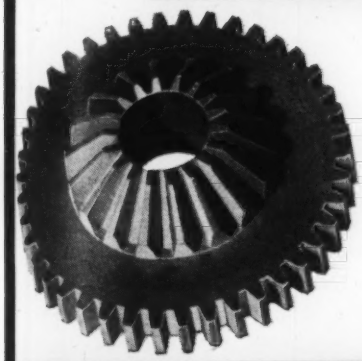
In Powder Metal they cost 80% less!

Products of Powdered Metal Products Corporation of America, Franklin Park, Illinois, specialists in gear making.

Bevel gear for power drill

Each of these gears is prohibitively expensive to make by conventional machining operations. In powder metal, each is formed at a single stroke.

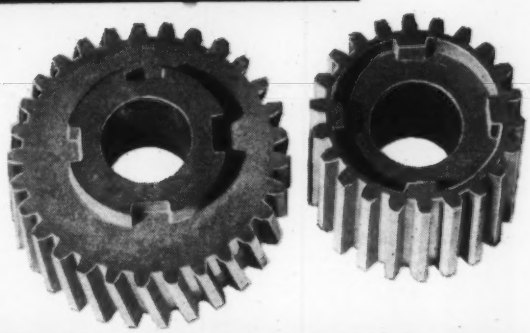
The small bevel gear for a power drill has a tensile strength of 100,000 psi. Savings in powder metal: 8 machine operations, 86% of total cost.



Spur and mitre gear for business machine

The mitre gear is used in a business machine. Savings in powder metal: 15 machining and assembly operations, 80% of total cost.

The helical and spur gear are used in an automatic washing machine transmission. Savings in powder metal: 18 machining and assembly operations, 88% of total cost.



Helical and spur gears for transmission in washing machine

To these and many other parts difficult or costly to form, powder metal processing is rapidly extending its many economies. Consult Stokes, makers of powder metal presses, on powder metal possibilities. Send parts or blueprints for report by Stokes engineers on their adaptability to powder metal processing.

A comprehensive booklet "Powder Metallurgy Today" will be sent on request.

STOKES

STOKES MAKES
Plastics Molding Presses,
Industrial Tabletting
and Powder Metal Presses,
Pharmaceutical Equipment,
Vacuum Processing Equipment,
High Vacuum Pumps and Gages,
Special Machinery

F. J. STOKES MACHINE COMPANY, 5984 TABOR ROAD, PHILADELPHIA 20, PA.

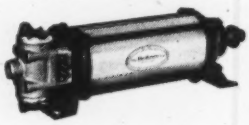
If you use air

This compact, 4-way electrically-controlled VALVE will simplify YOUR DESIGN PROBLEMS

The Bellows air-powered, electrically-controlled air valve is so fast it will complete 2000 or more movements a minute. Yet its unique low voltage solenoids will operate all day without discernible hum, pounding, or overheating. So sturdily built, in fact, that we guarantee its solenoid control units against burnout.

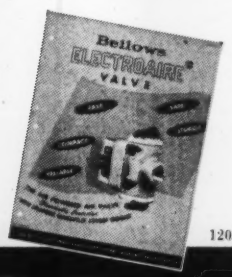
The Bellows Electroaire Valve* is so compact it can be held in the palm of a hand, yet it combines in one complete unit a four-way directional valve, piston speed regulators, and low voltage electrical controls. It will operate safely and efficiently even if submerged, covered with coolant, or piled high with dirt or chips. It is self-adjusting to widely varying air pressures . . . operates on 5 to 150 lbs. of air.

Made in ¼", ⅜" and ½" port sizes, the Bellows Electroaire valve can be adapted for direct connection to, or remote control of any standard air cylinder. It is a built-in feature of all Bellows "Controlled - Air - Power" Devices arranged for electrical control.



Write for These Free Bulletins

Case histories, wiring diagrams, technical data on the Electroaire Valve and other Bellows pneumatic equipment. Ask for Bulletin AV-300 and CL-30. Address: The Bellows Co., Dept. MD351, Akron 9, Ohio.



*TM Registered — Patent Pending

1201

The Bellows Co.

AKRON 9, OHIO

FASTER, SAFER, BETTER PRODUCTION — WITH "CONTROLLED-AIR-POWER"

Caterpillar together with bulldozers, cable controls and allied equipment. Manufacturers who will help fill the order are: **Hyster Co.** of Peoria, Ill., and Portland, Ore.; **Trackson Co.**, Milwaukee, Wis.; and **Balderson Co.**, Wamego, Kan. Perhaps by midyear, officials have said, the company may be operating under an Industrial Mobilization Plan calling for 62 per cent military production and 38 per cent essential civilian production. The plan, described as the first of its kind to be completed in the construction industry, has been used by the military as a model in developing similar plans in other industries.

♦

B. F. Goodrich Chemical Co., Cleveland, O., has concluded arrangements with several large Japanese industrial firms for the establishment of a new company, Japanese Geon Co. Ltd. Facilities will be constructed in Japan for the production of Geon polyvinyl chloride. Formation of the company has been approved by the Japanese Foreign Investment Commission and General Douglas MacArthur. In addition to B. F. Goodrich, principal stockholders are: Furukawa Electric Co. Ltd., Nippon Light Metal Co. Ltd., and Yokohama Rubber Co. Ltd., all of Tokyo. Engineers of B. F. Goodrich are to leave shortly for Tokyo to direct construction and initial operation; the plant will be completely staffed by Japanese.

♦

Rockwell Mfg. Co., Pittsburgh, Pa., has acquired both the Pittsburgh Valve and Fittings Division of the Pitcairn Corp. and the Pittsburgh Valve and Fittings Corp., a subsidiary of Pitcairn. Rockwell paid approximately $3,000,000 in a cash and stock-transfer arrangement. Manufacturing facilities and principal offices of Pittsburgh Valve are located in Barberton, O. Company-owned warehouses were also acquired in Kansas City and Houston. Leased warehouses are maintained in Chicago and New York. Included with the plant facilities is a foundry for the manufacture of valve castings. The plant will be operated as one of Rockwell's meter and valve divisions.

♦

Aluminum Co. of America will build a new alumina plant near Bauxite, Ark. Designed to process low-grade bauxite ore, the new plant will increase by nearly 50 per cent the amount of alumina now being produced by the company. To be operated by Aluminum Ore Co., wholly owned subsidiary of Alcoa, the new

NEW LINCOLN PLANT CREATED BY INCENTIVE-INSPIRED CO-ACTION IN DEVELOPING POSSIBILITIES IN PRODUCT

© LE Co. 1951

Machine frame designed in welded steel maintains alignment to .005"

Textile machine bed fabricated at The Warner and Swasey Company, Cleveland, Ohio, shows cast steel adapter welded to end of frame.

BY redesigning to a simpler, more economical welded steel construction, this prominent machine tool and textile equipment builder now maintains closer production tolerances while cutting the machining time from 8 hours to 2¼ hours. Alignment accuracy, held within .005" and squareness to within .0015 on the 120 inch frame members shown, is maintained with only one roughing and one finishing cut.

Originally the frame was fabricated from sheared plate using continuous corner welds. The present, simplified design incorporates steel tubing and four angles to which steel castings are welded at each end for subsequent assembly on side frame members.

In addition to saving 170 pounds of metal on each frame, welding time has been cut in half and stress relieving eliminated.

Welding engineers at Lincoln will gladly show you how to design your products in welded steel to improve performance and cut your manufacturing costs. Simply write or call.

HOW TO DESIGN FOR WELDED STEEL. Latest engineering data, techniques, speeds and costs are presented in the new 9th Edition Procedure Handbook of Arc Welding Design & Practice. Price only $2.00 postpaid in U. S. A.; $2.50 elsewhere.

the ACTUAL

Original Design *of bed frame for textile machine was difficult to machine accurately . . . required stress relieving.*

increasing the YIELD

Present Design *takes 21% less metal . . . 50% less welding . . . eliminates need for stress relieving.*

the IMMENSITY of the POSSIBLE

A 72% REDUCTION in machining time

SEE HOW STEEL DESIGN INCREASES ACCURACY

Machine Design Sheets free on request to designers and engineers. Write on your letterhead to Dept. 13,

THE LINCOLN ELECTRIC COMPANY

CLEVELAND 1, OHIO

Any machine is a better product when it is equipped with SEALMASTER ball bearing units. SEALMASTERS are designed and manufactured to give users the best possible bearing performance with the least amount of maintenance attention. An exclusive combination of the most important bearing features insure a long life of dependable service under the most exacting conditions. SEALMASTER units give superior performance in the field . . . the best proof of quality.

PERMANENTLY SEALED! Felt-lined steel flinger rotating in labyrinth prevents entry of dirt or loss of grease.

SELF-ALIGNING! Bearing unit, with seals independent of housing, aligns itself without seal distortion.

PRE-LUBRICATED! Proper amount of lubricant is placed in bearing chamber before shipment . . . unit is ready for immediate use.

NO HOUSING WEAR! Patented locking pin and dimple prevents rotation of outer race in housing, and positions bearing for relubrication . . . No housing wear means quiet operation.

SealMaster Ball Bearings are available in a complete line of standard units: Pillow Blocks • Flange Units • Hanger Units • Cartridge Units • Flange Cartridge Units • Take-Up Units.

BEARING DIVISION

STEPHEN S-A ADAMSON MFG. CO.

18 RIDGEWAY AVENUE, AURORA, ILLINOIS — LOS ANGELES, CALIF. ★ BELLEVILLE, ONT.

Factory Representatives and Dealers in All Principal Cities

plant will be situated on a 200-acre site adjoining the bauxite mining operations of Alcoa Mining Co., also a wholly owned subsidiary.

♦

Carpenter Steel Co., Reading, Pa., is having erected a new hot-rolling mill. The mill will be a combination strip, bar and rod mill designed to meet the requirements of the company's specialty production of tool, stainless and alloy steels. Production from the new mill will provide material for the firm's cold rolling and cold drawing departments as well as hot-rolled products for direct sale. The **Birdsboro Steel Foundry and Machine Co.** is building the mill.

♦

Meehanite Metal Corp., New Rochelle, N. Y., has announced that the **Empire Pattern and Foundry Co.,** Tulsa, Okla., will install Meehanite manufacturing processes. The latter will, in the future, manufacture Meehanite castings of various types.

♦

Cummins Engine Co. Inc., Columbus, Ind., is adding 9600 sq ft to its DD fuel pump building and also new machinery for increasing the production capacity for the Cummins DD fuel pump and component parts. An expenditure of $400,000 is involved.

♦

H. K. Porter Co. Inc., Pittsburgh, Pa., has formed the Jarecki Valve Division, Tulsa, Okla., to handle the manufacture and sale of Jarecki valves formerly produced at the Jarecki Mfg. Co. plant in Erie, Pa.

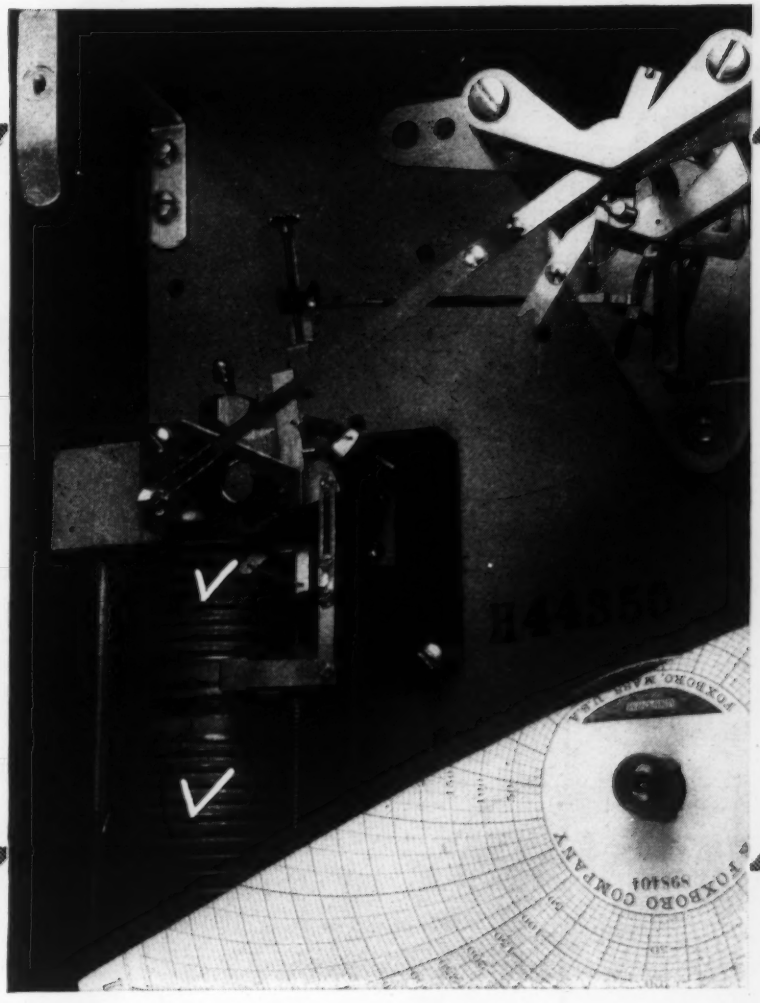
♦

Celanese Corp. of America will shortly begin construction of a large petro-chemical and cellulose acetate plant in the Edmonton area of Alberta, Canada. This addition will be used to accelerate the defense programs of the United States and Canada. Acetic acid produced in the new plant will be combined with wood pulp from the Columbia Cellulose Co. Ltd. plant at Prince Rupert, B. C., to manufacture cellulose acetate, the primary raw material for acetate yarns and plastics.

♦

Rockwell Mfg. Co., Pittsburgh, Pa., will build a new 150,000 sq ft manufacturing plant in Tupelo, Miss. Rockwell builds a variety of products among which are valves, gas meters and regulators, water meters, taxi meters, etc., and power tools.

Build better performance into your product *with* FLEXON BELLOWS



PRODUCT performance is dependent largely upon the performance of component parts . . . first rate performance requires first rate components. If metallic bellows are a part of your product you owe it to yourself to investigate FLEXON Bellows.

For the designer, FLEXON Bellows offer a combination that assures top notch performance and rigid adherence to specifications:

(1) Advanced manufacturing techniques permit fabrication of a wide variety of bellows and bellows assemblies as standard production items. This provides a higher degree of uniformity and resultant lower ultimate cost to you.

(2) Skilled manufacturing personnel with long experience have an appreciation of your problems and the importance of exact compliance with your specifications.

FLEXON Bellows are available in stainless steel, brass, bronze and other alloys with sizes ranging upward from 5/16" I.D. Whatever your requirements in bellows or bellows devices, check with CMH first. Experienced CMH engineering assistance is available to help you in the design or selection of the proper bellows to meet your needs.

Write for a copy of the new Flexon Bellows catalog. For specific recommendations send details of your application.

Illustrated above is a close-up of the mechanism of an absolute pressure recorder manufactured by the Foxboro Company in which FLEXON stainless steel bellows are used.

Flexon identifies CMH products that have served industry for over 49 years.

CHICAGO METAL HOSE Corporation

1339 S. Third Ave. • Maywood, Ill. • Plants at Maywood, Elgin, Rock Falls, and Savanna, Ill.
In Canada: Canadian Metal Hose Co., Ltd., Brampton, Ont.

CMH

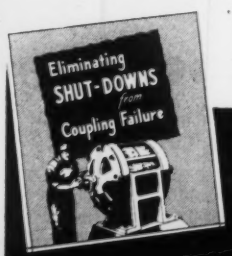
ONE DEPENDABLE SOURCE
for every flexible metal hose requirement

Convoluted and Corrugated Flexible Metal Hose in a Variety of Metals • Expansion Joints for Piping Systems
Stainless Steel and Brass Bellows • Flexible Metal Conduit and Armor • Assemblies of These Components

FOR PROVEN COUPLING SERVICE ON

WALDRON
Improved
Gear Type

From every standpoint—design, construction, operating features—these WALDRON Couplings give greater assurance of longer, trouble-free service. No other coupling has so many major construction features for greater operating advantages. An examination of its many design refinements will quickly explain why the WALDRON coupling is so consistently specified for all types of applications where dependability of performance is a first essential.



Write for this Helpful Folder
explaining coupling features which give added insurance against coupling failure. No obligation.

JOHN WALDRON
CORPORATION
New Brunswick, New Jersey
Authorized Sales Representatives in Principal Cities

SOCIETY ACTIVITIES

Scientific instrument manufacturers of the nation have suggested that certain special instruments and apparatus essential in the event of atomic raids be registered and pooled so that their location be immediately known to proper persons. Acting through the **Scientific Apparatus Makers Association**, the manufacturers have written to the administrator of the Federal Civil Defense Agency, "Products of this industry will be needed in your program to detect atomic radiation, chemical weapons and biological aerosols; in first aid stations, treatment centers and hospitals, and in clinical laboratories which serve all three; for decontamination, and for a dozen other essential uses. . . .We suggest that the Scientific Apparatus Makers Association is the best equipped and most logical organization for registering such instruments. Its companies make and distribute them, consequently they know where they are located and of what they are capable."

The instrument industry recently requested a listing of all instruments needed by state and local organizations, and specifications for instruments not yet developed, with an offer to develop the new instruments.

♦

The **American Society of Industrial Engineers** *Merit Award* has been given to the Westinghouse Electric Corp. for "leadership in research, engineering, design and manufacture in the home laundry equipment field."

♦

Joseph L. Kopf, president of the **National Metal Trades Association**, has announced the appointment of members to the Industrial Engineering Committee for 1951. Named are: A. S. Davis, Dexter Folder Co.; John J. Hall, personnel administrator, Brown & Sharpe Mfg. Co.; W. L. Johnson, vice president, Bell & Howell Co.; Robert J. Jones, assistant to the treasurer, Crouse-Hinds Co.; and W. E. Rutz, executive vice president and works manager, Giddings & Lewis Machine Tool Co. A. S. Davis will act as chairman of the committee. The new appointees have begun work on studies to assist in estab-

G-E ADJUSTABLE-SPEED DRIVE CUTS MILLING TIME BY 1/3

Exact speed set with finger-tip ease to meet varying job requirements

According to engineers of the Judson Steel Corporation, Oakland, Calif., a G-E Type ACA motor has reduced the time necessary to mill deformations on steel rolls by as much as 33%—and with less wear or damage to cutting heads.

The steel rolls are in turn used to process concrete reinforcing bars, and cuts vary in depth and number according to size of type of bars to be rolled. The ACA motor makes possible quick and accurate speed adjustment so that proper cutting speeds may be chosen to meet any specifications immediately. Higher speeds may be selected for smaller, shallow cuts—slower for deep cuts.

The ACA motor, one of G-E's adjustable-speed family, is helping manufacturers in every field to increase production with improved quality control, saving scarce materials, cutting rejects, and increasing versatility of existing machinery. There's a good chance that one or more of this versatile adjustable-speed drive family can do the same for you. Send the coupon below for complete details. *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

Speed of the ACA motor driving this milling machine is quickly set by a twist of the nob on top to match machine speed to any given job.

WHICH DRIVES ARE BEST FOR YOU?

This 26-page manual will help you decide. It shows you how to go about selecting *the right* drive. The handy drive chart included is worth your detailed study. Bulletin GEA-5334. Check here. . . . . ☐

General Electric Company, Section B 646-9
Apparatus Department, Schenectady 5, N. Y.

Please send me the bulletins checked:

☐ for reference only

☐ for planning an immediate project

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

THE ACA MOTOR—*Speed ranges to 20:1*—An adjustable-speed a-c motor. Speed range 3:1 or 4:1 continuous; for intermittent operation from 6:1 to 20:1. Bulletin GEA-4883. Check here. . . . . ☐

THE SPEED VARIATOR—*Speed ranges to 40:1*—An adjustable-voltage d-c drive that uses a-c power. Speed ranges 8:1 to 40:1 and beyond. Bulletin GEA-5335. Check here. . . . . ☐

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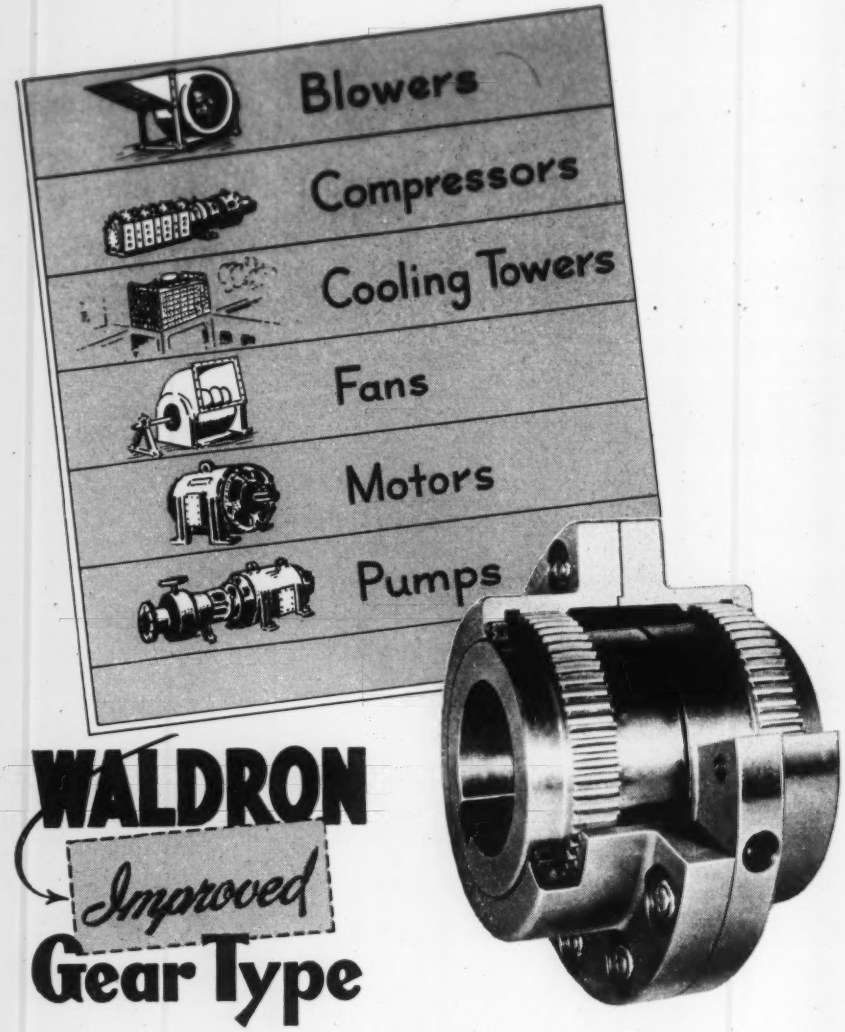
** Thy-mo-trol is the General Electric Company's registered trademark for its electronic motor-control system.*

Headquarters for ELECTRICAL ADJUSTABLE-SPEED DRIVES

GENERAL ELECTRIC

646-9

FOR PROVEN COUPLING SERVICE ON



WALDRON
Improved
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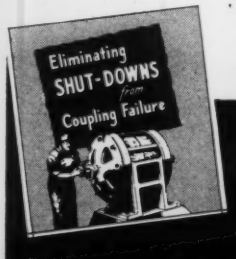

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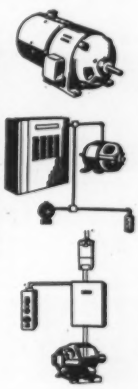

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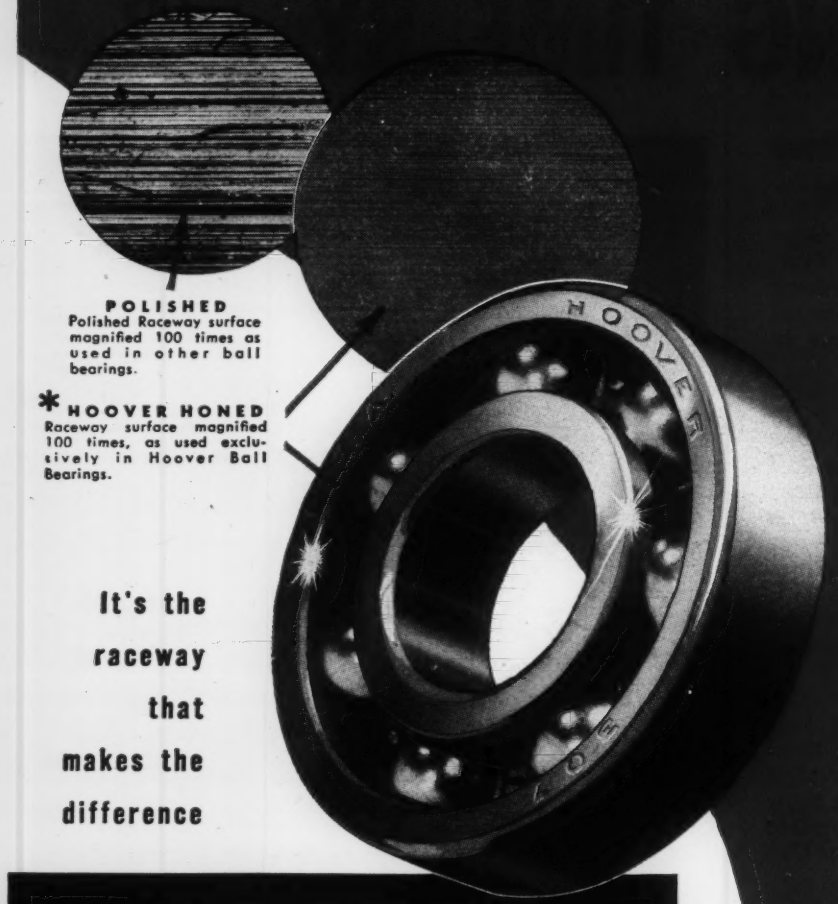
Nothing is as smooth as a

HOOVER HONED RACEWAY*



POLISHED
Polished Raceway surface magnified 100 times as used in other ball bearings.

* HOOVER HONED
Raceway surface magnified 100 times, as used exclusively in Hoover Ball Bearings.

It's the raceway that makes the difference

HOOVER
America's only
BALL BEARING
with Honed Raceways

90% longer life
30% greater load
Amazing Quietness

The Aristocrat of Bearings

HOOVER BALL AND BEARING CO.
ANN ARBOR, MICHIGAN

lishing sound and practical wage and salary administration programs to meet the needs of industry in the critical months ahead. The Industrial Engineering Committee, which has functioned for several years, has developed the National Metal Trades Association's job, salary and employing rating plans used in industrial plants throughout the country.

♦

The **Institute of Aeronautical Sciences,** during its Nineteenth Annual Meeting in New York, presented:

1950 *Guggenheim Award* to Dr. Hugh L. Dryden, director of the National Advisory Committee for Aeronautics, for his "outstanding leadership in aeronautical research and fundamental contributions to aeronautical science."

John Jeffries Award to Brig. Gen. Otis O. Benson Jr., USAF (MC), for "outstanding contributions to the advancement of aeronautics through medical research."

Reed Award to Robert R. Gilruth, chief of the Pilotless Aircraft Research Division of Langley Aeronautical Laboratory NACA, for the "conception and development of new techniques for obtaining transonic and supersonic data using freely flying models."

Robert M. Losey Award to Roscoe R. Braham Jr., research associate New Mexico School of Mines, "in recognition of outstanding contributions to the science of meteorology as applied to aeronautics."

Lawrence Sperry Award to Frank N. Piasecki, chairman of the board of the Piasecki Helicopter Corp., for "notable contribution made by a young man to the advancement of aeronautics." Piasecki pioneered in the development of the tandem-rotored helicopter and it was his organization that produced the world's first transport helicopter of that type to fly successfully.

♦

At the annual meeting of the **Aluminum Association** in New York, A. P. Cochran of the Cochran Foil Co. Inc., was elected president for the ensuing year. Elected to serve as vice presidents are: I. T. Bennett, Revere Copper & Brass Inc.; L. M. Brile, Fairmont Aluminum Co.; and E. G. Fahlman, Permold Co. A. V. Davis, Aluminum Co. of America was re-elected chairman of the board and Donald M. White was reappointed secretary and treasurer. Member companies of the association account for all the primary aluminum production in the U. S. and about 85 per cent of aluminum semifabricated products.

NEW C-D Silicone Dilecto withstands an inferno of heat and electricity

to improve product performance for you!

There are three new grades of C-D Dilecto* that can withstand temperatures as high as 250°C. They are chemically inert, silicone-glass laminated plastics that offer exceptionally high heat resistance and good arc resistance, extra strength, and positive moisture resistance! At Continental-Diamond we've literally lived and worked with Silicone Dilecto—perfecting it to a point where we believe it can be highly useful in helping to solve your production problems — and improve product performance.

your partner in producing better products

And this remarkable plastic is but one of many in the C-D family. They provide practical combinations of mechanical, electrical, and chemical properties—structural strength, light weight, positive moisture, heat and corrosion resistance. In hundreds of plants, C-D Plastics—Fibre, Vulcoid, Dilecto, Celoron, and Micabond—offer proof that it pays to see C-D first in your search for the right plastic for the job. For interesting, useful information on Silicone Dilecto, and other C-D high strength plastics, call or write your nearest C-D office, soon.

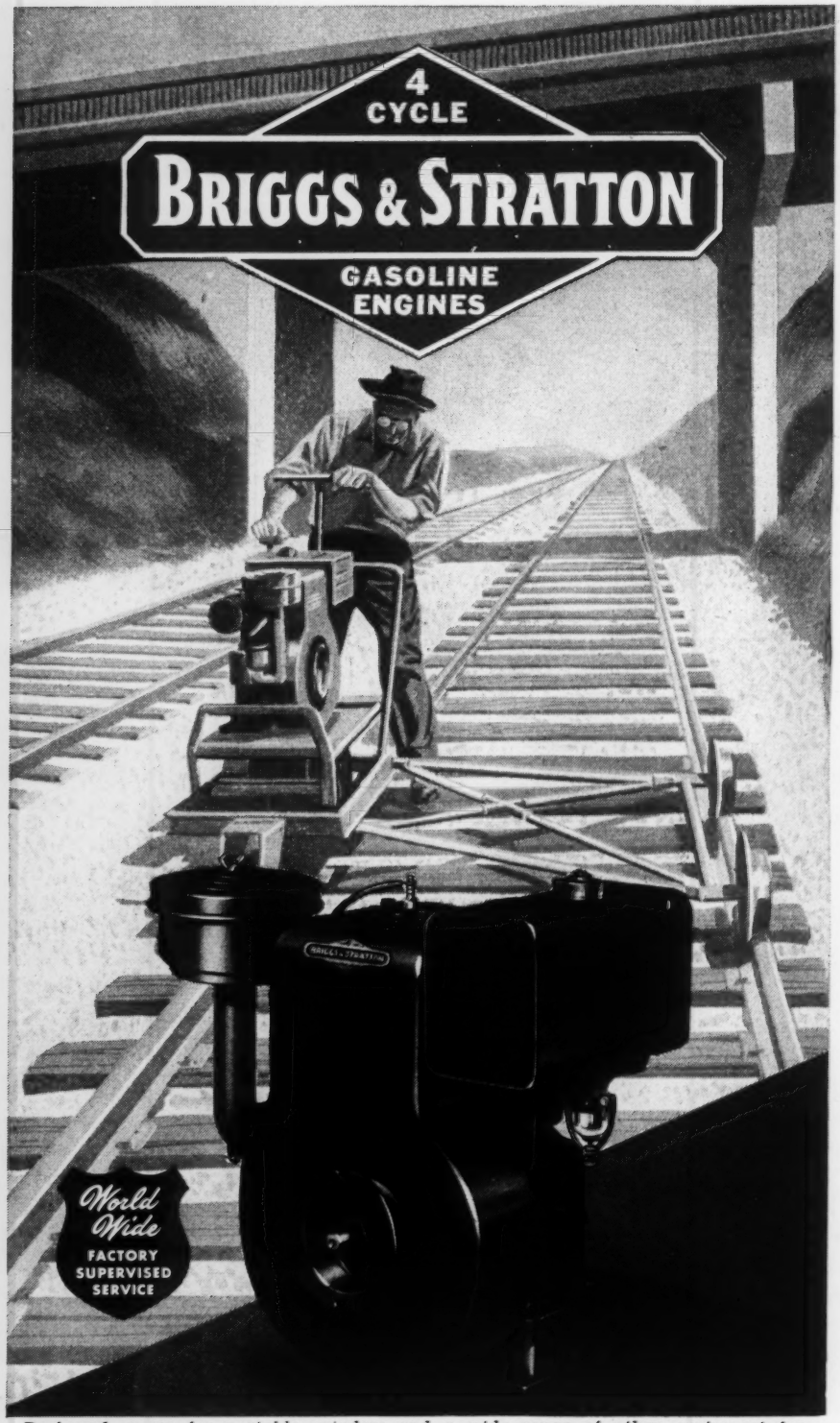
*Dilecto GB—112—S
Dilecto GB—128—S
Dilecto GB—261—S

DE-2-49

BRANCH OFFICES: NEW YORK 17 • CLEVELAND 14 • CHICAGO 11 • SPARTANBURG, S. C. • SALES OFFICES IN PRINCIPAL CITIES
WEST COAST REPRESENTATIVE: MARWOOD LTD., SAN FRANCISCO 3 • IN CANADA: DIAMOND STATE FIBRE CO. OF CANADA, LTD., TORONTO 8

Continental-Diamond FIBRE COMPANY

Established 1895 . . Manufacturers of Laminated Plastics since 1911 — NEWARK 23 DELAWARE



Preferred power for portable grinders and a wide range of other equipment for railroad maintenance — the world's most widely used single-cylinder gasoline engines on machines and tools for industry, construction, railroads, oil fields, etc., and on appliances and equipment for farm and home.

ONLY Briggs & Stratton can give you the benefits of more than 30 years of air-cooled power experience — gained in the production of more than 5,000,000 single-cylinder, 4-cycle, air-cooled gasoline engines.

Briggs & Stratton Corporation, Milwaukee 1, Wis., U.S.A.

In the automotive field Briggs & Stratton is the recognized leader and world's largest producer of locks, keys and related equipment.

SALES AND SERVICE
PERSONNEL

APPOINTMENT of **S. T. Mackenzie,** head of the Philadelphia office of the Babcock & Wilcox Co., to the newly created post of sales manager was announced recently. Mr. Mackenzie, who will make his headquarters in New York, joined the company in 1934 and had been in charge of the Philadelphia office since 1946. **R. W. Buntin** will become district sales manager of the Philadelphia office to replace Mr. Mackenzie. Also, **Frank E. Hutton,** of the company's New York office, was recently appointed to the position of executive assistant in charge of the application and sales of heat and chemical recovery equipment, digesters, alloy castings and other process equipment for the pulp and paper industry. In addition, he will direct the sales of process equipment and alloy castings generally and of pulverizers for cement, metallurgical and special applications.

♦ ♦ ♦

At a recent meeting of the board of directors of the Lincoln Electric Co., **W. R. Persons** was elected vice president in charge of sales. He has been general sales manager of the company since 1946 and before that served in various capacities in welding development and the sale of welding equipment.

♦ ♦ ♦

John W. Belanger of Schenectady, N. Y., and **Nicholas M. DuChemin** of Lynn Field, M[illegible], have been named general managers of the large apparatus divisions and small apparatus divisions, respectively, of the General Electric company's apparatus department. Formerly, they were assistant general managers of the department and in their new capacities will be responsible to **Henry V. Erben,** vice president.

♦ ♦ ♦

Link-Belt Co., manufacturer of materials handling and power transmission machinery, has announced that **Andrew K. Kolar,** district manager at Moline, Ill., has been appointed assistant sales manager for Pershing Road plant products, with offices at 300 West Pershing Rd., Chicago, Ill. Succeeding Mr. Kolar, **Stuart T. Penick,** heretofore district engineer at Dallas, Tex., has been transferred to Moline in the capacity of district

ANCHOR

Assembled Hydraulic Hose Units

Tailor-made to Keep Your Costs Down–Performance Up

Factory-assembled to your specifications—save you time and money, give you a better job

For extra protection against leaks and blow-offs at high pressures use factory-applied Anchor Ductile Sleeve Hose Couplings with their exclusive patented grip.

Anchor adapter unions save assembly time and piping expense. Use them and other styles of related Anchor fittings to simplify your piping problems.

FOR longer service life — you design your machines with great care and manufacture them to rigid tolerances.

But the job is not done until you invest the same care in selecting and specifying hose units. After all, the performance of your machines is dependent upon them.

That's why Anchor offers factory-assembled hose units. They are made to exact lengths in accordance with your drawings. And the couplings are factory-applied by experts with specially designed machines to give you leakproof dependability and extra safety. They cost less in the long run — because they give better service, keep your customers satisfied.

Shown here is a rayon two-braid hose-assembly designed for medium and low pressures. Made from specially selected synthetic rubber, it has excellent flexibility. This same unit is also available in a single-wire braid hose.

For high pressures Anchor Ductile-sleeve hose-couplings are your best choice.

Take out performance insurance. Reduce assembly time and costs in your plant and in the field. Equip your machines with Anchor factory-assembled hose units.

Send for complete information on Anchor assembled hose units.

Clip coupon to company letter head —and mail TODAY!

ANCHOR COUPLING CO. INC.
Factory: Libertyville, Illinois • Branch Detroit, Michigan

ANCHOR COUPLING CO. INC., Dept. MD31
Libertyville, Illinois

I like the dependability, the safety, and the time-and-money-saving features of Anchor Assembled Hose Units. Please send me Bulletin No. 498.

Name..... Position.....

Company.....

Company Address.....

City.....(.....) State.....

D-3

MORE COMPACT DESIGNS

LIGHTER WEIGHT

INCREASED OPERATING EFFICIENCY

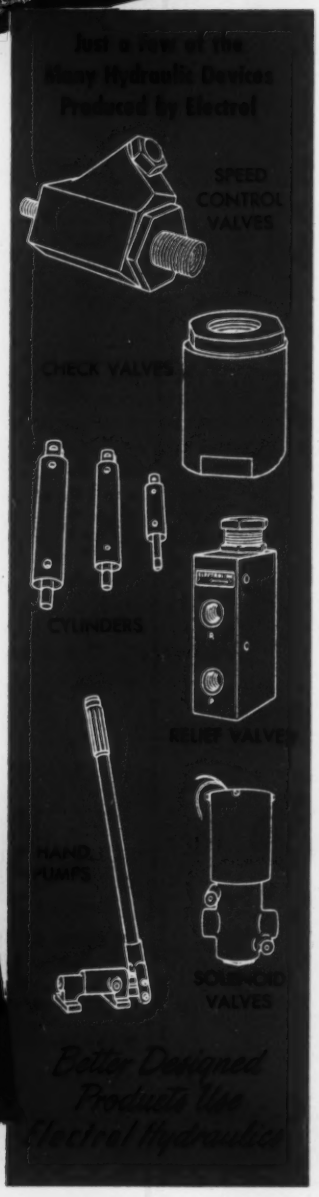
LONGER SERVICE LIFE

LESS MAINTENANCE

There are many new outstanding design features in today's best-known machines of industry, transportation and agriculture—engineering advancements that add up to provide greater efficiency . . . new ease of operation . . . and lower on-the-job cost.

Design engineers—the men responsible for these product improvements—will also tell you that many of these new advantages and economies stem from the wider use of Electrol's better hydraulic devices.

It will pay you to look for the use of Electrol hydraulic devices in the equipment you buy . . . and it will pay you to feature their use in the products you make and sell.



Electrol
INCORPORATED
KINGSTON, NEW YORK
CYLINDERS • SELECTOR VALVES • FOLLOW-UP VALVES
CHECK VALVES • RELIEF VALVES • HAND PUMPS
POWERPAKS • LANDING GEAR OLEOS • SOLENOID
VALVES • ON-OFF VALVES • SERVO CYLINDERS • TRANSFER
VALVES • CUT-OUT VALVES • SPEED CONTROL VALVES
FOR BETTER HYDRAULIC DEVICES

manager. The company also announced that **Charles W. Beauchamp,** formerly assistant sales manager, silent chain drives at the Ewart plant, Indianapolis, has been appointed assistant sales manager for both silent and roller chain in the Ewart plant. **H. Merrill Bowman,** formerly assistant sales manager at the company's Pershing Road plant, has been appointed assistant sales manager of the Ewart plant for Ewart general products.

♦ ♦ ♦

With responsibility for the engineering and sales of the company's line of power transmission equipment and rotary pumps, **W. A. Neumann Jr.** has been appointed manager of the IMO-De Laval Products division of the De Laval Steam Turbine Co.

♦ ♦ ♦

Domenic A. DiTirro has been named head of the sales and technical service engineering divisions of the Ross Operating Valve Co., 120 East Golden Gate, Detroit. He was formerly with the Parker Appliance Co. of Cleveland in various capacities, the last of which was chief research and development engineer. He has wide experience in both hydraulics and pneumatics and is the author of many technical articles on these subjects.

♦ ♦ ♦

A leave of absence has been granted to **Paul B. Andrews,** merchandise sales manager of Revere Copper and Brass Inc., to serve as chief of the brass mill section, copper division of the National Production Authority.

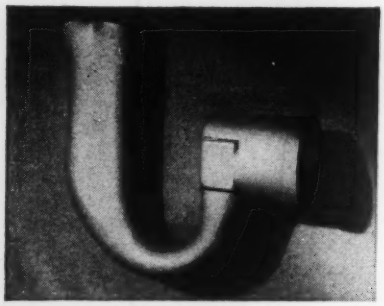
♦ ♦ ♦

Frederick G. Weigand of the chemical department of General Electric Co. has been appointed sales manager of alkyd resin products. In his new post, Mr. Weigand will have responsibility for the sale of Glyptal, a registered trade mark for alkyd resins, insulating varnishes and compounds, Formvar enamel, plasticizers and Permafil products. He will have his headquarters at Schenectady, N. Y.

♦ ♦ ♦

Kennametal Inc., Latrobe, Pa., has announced the appointment of **Bennett Burgoon Jr.,** as assistant to the general sales manager, **W. D. Turnbull.** Mr. Burgoon was district manager in the Detroit-Cleveland area before his appointment to headquarters sales. **Gilbert Bunn,** manager of the Philadelphia-New York district for the last three years, has been appointed manager of the Detroit-

you Specify
if it's a wire spring .
spring washer . . . . . .
flat spring . . . . . .
or wire form . . . . .
we make it!
Wallace Barnes Springs
Bristol Connecticut



This tough, Well-Cast magnesium portable tool part is typical of how light you can make *your* product. It weighs only a few ounces.

Want to lose some weight?

40 years' experience

ALUMINUM AND MAGNESIUM SAND, SEMI-PERMANENT AND PERMANENT MOLD CASTINGS. WELL-MADE WOOD AND METAL PATTERNS.

THE WELLMAN BRONZE & ALUMINUM CO.

2512 EAST 93rd STREET • CLEVELAND, OHIO

Cleveland district, succeeding Mr. Burgoon, and **Douglas C. Cunningham,** formerly representative in the Detroit district, has been appointed manager in the Philadelphia-New York district.

♦ ♦ ♦

Thomas O. McMillan, 342 South Second St., Lebanon, Pa., has been appointed eastern district representative for the Warner Electric Brake & Clutch Co., Beloit, Wis. Mr. McMillan plans to make Lebanon his headquarters and will service the entire eastern area with the exception of part of New Jersey and New York City.

♦ ♦ ♦

Precision Rubber Products Corp., Dayton, O., manufacturer of O-ring seals, has announced the appointment of **Edward N. Cunningham** to its technical sales staff. Prior to joining the company, Mr. Cunningham was a technical sales representative for the rubber division of Enjay Co. Inc., New York. During his nine years with Enjay Co., he was closely associated with the early development of the Nitrile and Butyl types of synthetic rubbers, as well as with active field sales and market development work.

♦ ♦ ♦

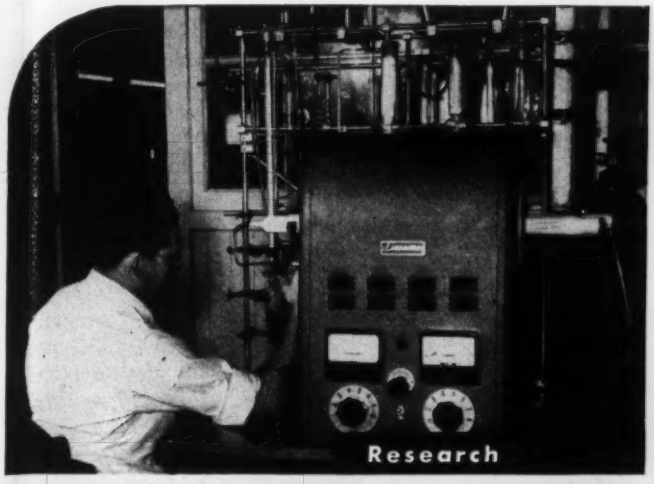
Carl J. Meister has been appointed vice president and director of sales of the Atlas Chain and Mfg. Co., Philadelphia. In addition to his new duties, Mr. Meister will serve as director of sales for the Atlas Metal Stamping Co., Philadelphia. He will continue to make his headquarters at the main plant in Philadelphia.

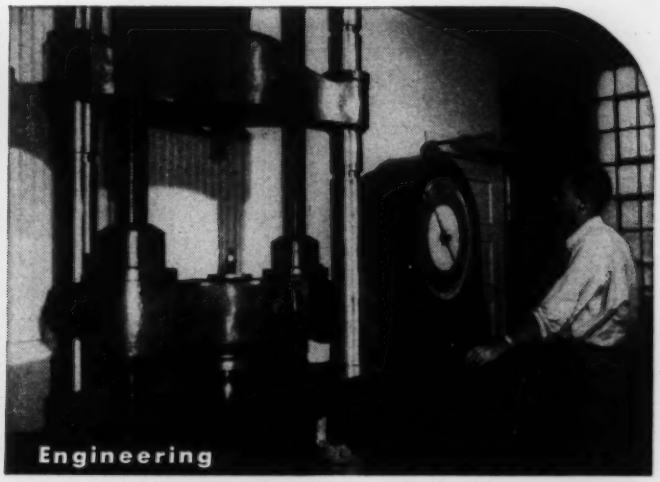
♦ ♦ ♦

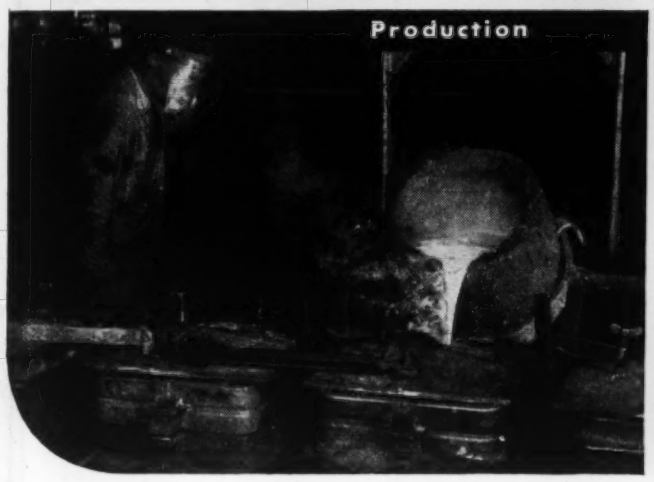
The Michigan Abrasive Co. has announced the promotion of **C. H. Wills** from sales manager to director of sales. At the same time **Barnard S. Meade** was appointed sales manager.

♦ ♦ ♦

A series of promotions in the sales department of Allegheny Ludlum Steel Corp. was announced recently. **R. A. Lincoln,** previously assistant manager, has been appointed manager of the sales development and engineering service department, succeeding **William B. Pierce,** who was recently appointed technical director of the company. **C. R. Mitchell,** formerly assistant to the manager of stainless steel sales, has been appointed to the newly created position of manager of stainless strip sales. **R. S. Robinson,** who had served as assistant to the general manager of sales, has been named manager of carbon steel sales, a newly created







WHICH

N.B.M. service is most important

FOR PRODUCING BETTER BRONZE BEARINGS AND CASTINGS?

The answer is that *ALL FOUR* are equally important... and ALL FOUR represent the reasons why more and more users of Non-Ferrous Bearings and Castings become N-B-M Customers.

The complete facilities of National Bearing Division for Research, Engineering, Production and Finishing are unique. They represent an important *chain of service*—an ability to translate your *problems* into *requirements,* and requirements into *actual products* that serve you better.

The most modern equipment for alloy testing, molding, casting and finishing assures you of finer, more dense, closer-to-size bearings and castings—products that have higher resistance to wear and greater long-range economy.

Yes, this complete N-B-M Service is worthwhile investigating. Call in your nearest N-B-M Representative—he will gladly show you how this service can be geared to serve you with maximum efficiency.

THIS NEW CATALOG completely describes N-B-M Facilities—how they can cut costs for you and tie in with your own production. Write for a free copy today.

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NATIONAL BEARING DIVISION

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PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

Why
Allen ⬡ Head
Set Screws
Hold Better
Look Better
The purpose of the point is to hold the shaft against both rotation and longitudinal motion. The Allen screw with the correct point* does the job best.
Locking is a matter of friction. High uniform accuracy of fit, pitch diameter and perfect thread lead assure maximum thread contact. Twelve and a half inches of thread provide one and one half square inches of contact in a ½" x ¼" Allen ⬡ Head Set Screw.

Improved heat treatment of Allen ⬡ Head screws produces greater Rockwell hardness and strength to permit firmer tightening. The Allen cup point grips the shaft without producing chips or particles. Ideal for use and *re-use* under vibrating stress conditions.

Always the choice for the best in precision screws . . . ALLEN ⬡ HEADS

* Cup point for most applications. Cone, flat, half dog and oval points are standard Allen points available from stock for special requirements.

WARNING
Allen-Type screws aren't necessarily Allen-Made.
Get genuine "Pressur-Formed" Allen ⬡ Head screws in this black and silver box.

ALLEN ALLEN HEAD
MANUFACTURING COMPANY
Hartford 2, Connecticut, U. S. A.
NEW YORK, CLEVELAND, DETROIT, CHICAGO, LOS ANGELES

position including responsibility for both finished and semifinished carbon steel sales. **Frank F. Young** was named assistant manager of the Pittsburgh district sales office, with which he has been associated for many years.

♦ ♦ ♦

Robin S. Kersh, formerly manager of central station sales for the Westinghouse Electric Corp., has been named manager of the company's steam division at South Philadelphia, Pa. The appointment was announced by **David W. R. Morgan,** vice president in charge of both the steam and aviation gas turbine divisions. Mr. Morgan has been acting as manager of the steam division in addition to his other duties.

♦ ♦ ♦

The Trumbull Electric Mfg. Co., of Plainville, Conn., has announced the appointment of **J. J. Pascher** as district sales manager of its New York district. He has been manager of the Hartford office of the General Electric Co. since 1945, and prior to that was sales engineer in the industrial division of the apparatus department's New York office.

♦ ♦ ♦

C. Russell Conklin, eastern district manager for the Republic Rubber Division of Lee Rubber & Tire Corp., has been named to take over the management of Republic's Philadelphia office, 22nd and Race Sts., Philadelphia, Pa. **Warren Ingersoll,** who formerly was in charge of this office will now devote all his time to his duties as assistant to the president of the Lee Corp. and will be located at the corporation's main office in Conshohocken, Pa. The company also announced the appointment of **Ray Beveridge** to the position of field engineer, with headquarters at the Philadelphia district office.

♦ ♦ ♦

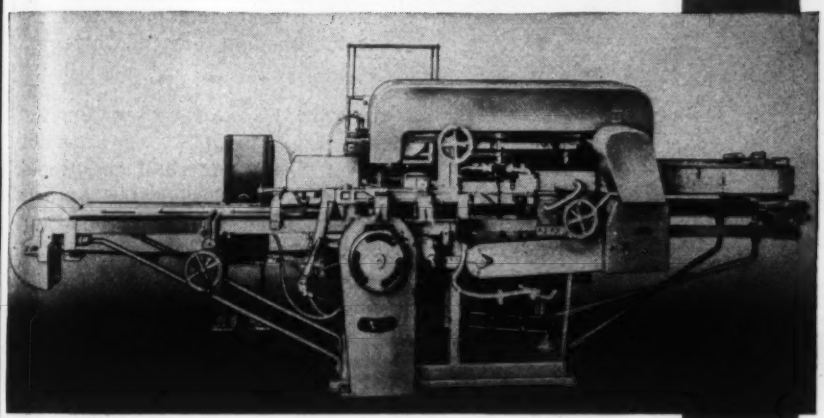
Two new officers were recently elected to the railway division of the National Malleable and Steel Castings Co. **Herbert L. Mausk** was elected vice president of sales, railway division, and **Ellsworth H. Sherwood** was elected assistant vice president of sales, railway division.

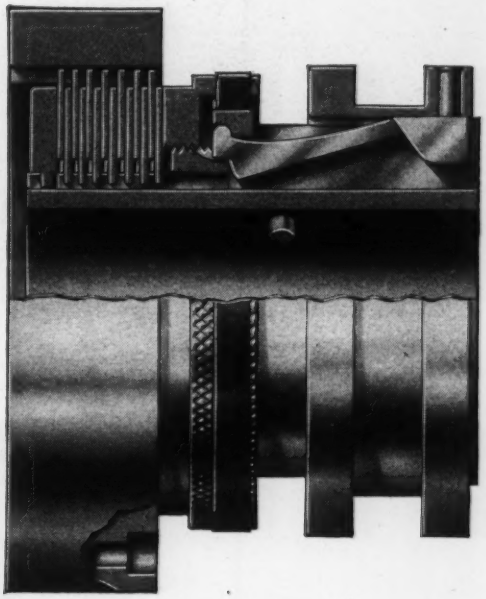
♦ ♦ ♦

Theodore A. Smith, who for the past five years has headed the sales activities of the RCA engineering products department, has been appointed assistant general manager of the department. In his new post, Mr. Smith assumes the duties of **W. Walter Watts,** vice president and

MAXITORQ

Keeps Good Company





...in the PACKAGING FIELD

The MAXITORQ floating disc CLUTCH takes care of power transmission in this Model FF packaging machine, used in freezer plants to overwrap frozen food packages.

The Package Machinery Company, Springfield, Mass., one of the largest manufacturers of packaging machinery in the world, builds approximately 100 different models of machines. Their engineers say, "We have been so well satisfied with the Maxitorq Clutch that we have adopted it as standard on practically all machines we build that require a clutch type of drive."

This specific Maxitorq is the NO. 23, single dry type, 1 H.P. at 100 r.p.m., 4-1/32" long, 3-15/16" dia. There are 8 standard capacities, 1/4 to 15 H.P. single or double, wet or dry. Separator springs keep discs "floating" in neutral... prevent drag, abrasion, heating. Assembly, adjustment, take-apart are manual... no tools required. Disengagement is instant and complete.

Within its capacity, the Maxitorq Clutch serves many applications for machine tools, industrial products, mowers, textile, printing, mining, lumbering, packaging and a host of other machines. Ask for our engineering recommendations... join "Maxitorq's good companies."

Send for Catalog No. MD3

1CJ51

THE CARLYLE JOHNSON MACHINE COMPANY

MANCHESTER • CONNECTICUT

When top production is a must—
you can always rely on
FAWICK CLUTCHES AND BRAKES

Fawick Clutches and Brakes have "performance-proved" their reliability and advantages to the press and metal-working industry.

They have proved that the split-second action of Fawick units produces faster starts and stops, resulting in shorter operating cycles and increased production.

They have proved that the safe, positive action of FAWICK units delivers FULL power and that they contribute greatly to continuous top-efficiency production by the elimination of down-time for adjustment or lubrication.

In addition, operators have their choice of the well-known Fawick "E" Brake, if they prefer an air-applied brake, or the new Fawick "S" Brake if they prefer a spring-applied, air-released brake.

When you consider the additional Fawick advantages of operator safety, machine overload protection (at a selected air pressure), and unequalled low maintenance, your most practical answer to peak production on your machines is FAWICK Airflex Clutches and Brakes.

FAWICK AIRFLEX COMPANY, INC.
9919 CLINTON ROAD • CLEVELAND 11, OHIO

For detailed information on the advantages of FAWICK CLUTCH AND BRAKE UNITS as they apply to your machine problem call or write the Main Office, Cleveland, Ohio, for Bulletin 300.

FAWICK Airflex
INDUSTRIAL CLUTCHES AND BRAKES

general manager of the engineering products department, who has been granted a leave of absence to serve with **Maj. General William H. Harrison,** Defense Production Administrator, in Washington. At the same time, announcement was made of the appointment of **A. R. Hopkins** as general sales manager of the department and that of **Barton Kreuzer** as general product manager.

♦ ♦ ♦

W. A. Finn has been named general European manager of Worthington Pump and Machinery Corp., Harrison, N. J., and will be located in Paris. He replaces **A. W. Fraser,** who is assuming an executive sales position with the company and will make his headquarters in Chicago.

♦ ♦ ♦

Aerovox Corp. of New Bedford, Mass., has announced the appointment of **Frank Marshall** as director of manufacturers' sales for Aerovox Corp. and Electrical Reactance Corp. **A. E. Quick** will succeed Mr. Marshall as sales manager of Aerovox Corp., manufacturers' sales division and will make his headquarters in New Bedford. Mr. Quick was formerly sales manager of Electrical Reactance Corp. **Charles Golenpaul** will continue to direct Aerovox jobber sales, and **Carl Bretz,** formerly assistant sales manager of Electrical Reactance Corp., will assume new duties as sales manager for that company with headquarters in Olean, N. Y.

♦ ♦ ♦

William Cranford has been appointed to the sales engineering staff of Cannon Electric Development Co., Los Angeles. Prior to this appointment, Mr. Cranford served in various Cannon Electric departments, such as electrical maintenance, engineering, and the research laboratory.

♦ ♦ ♦

A. G. Hendrickson has joined the A. O. Smith Corp. as welding equipment sales manager. He will function under welding division sales manager **L. F. Vonier,** who until now had actively managed sales of both welding electrodes and welding machines. Mr. Hendrickson comes to A. O. Smith from the Harnischfeger Corp., where he was assistant manager of the welder sales division.

♦ ♦ ♦

Mahlon M. Matchett has been appointed sales engineer for the Illinois Tool Works, Chicago. With headquarters in the Detroit office, Mr. Matchett will be associated with the company's tool and machine division.

Specify POPE PRECISION SPINDLES

Sealed Package Direct Motorized Cartridge Type Precision Spindles

Here's Why:

1. **POPE Spindles produce finer finishes.** They have the necessary massive construction and the radial and axial rigidity — *two* double-row, *super-precision,* cylindrical roller bearings and *two* separate ball thrust bearings.

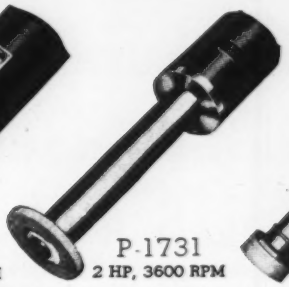
2. **POPE Spindles increase production.** They have the power, the bearing capacity and the rigidity to carry a heavy cut. Rapid metal removal combined with superior final finish saves much operating time.

3. **POPE Spindles come in sizes to fit YOUR job.** They come in ½, 1, 2, 3, 5, 7½ and 10 HP and in 3600, 1800 or 1200 RPM to suit the work or the tool.

4. **POPE System of sealed-in lubrication** permits operation horizontally, vertically or at any angle — on boring mills, planers, millers, and other machine tools as well as on surface grinders.

5. **POPE Spindles require no maintenance costs** for lubrication or adjustments. This is just another bonus you get by specifying POPE Spindles.

P-34
½ HP, 3600 RPM



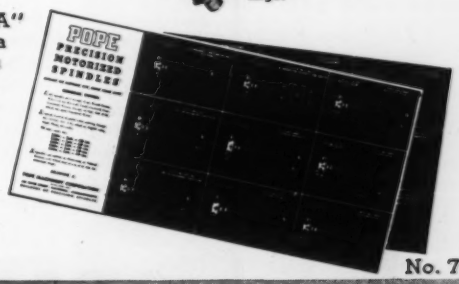
P-1731
2 HP, 3600 RPM

P-771
5 HP, 3600 RPM

P-772
10 HP, 3600 RPM (Shown in bracket). Mounting brackets are available for all spindles.

P-32T
1 HP, 3600 RPM, over-all length 25½", 3" or 3½" dia. barrel. Cut-away view (above) shows the permanently preloaded, permanently lubricated bearings.

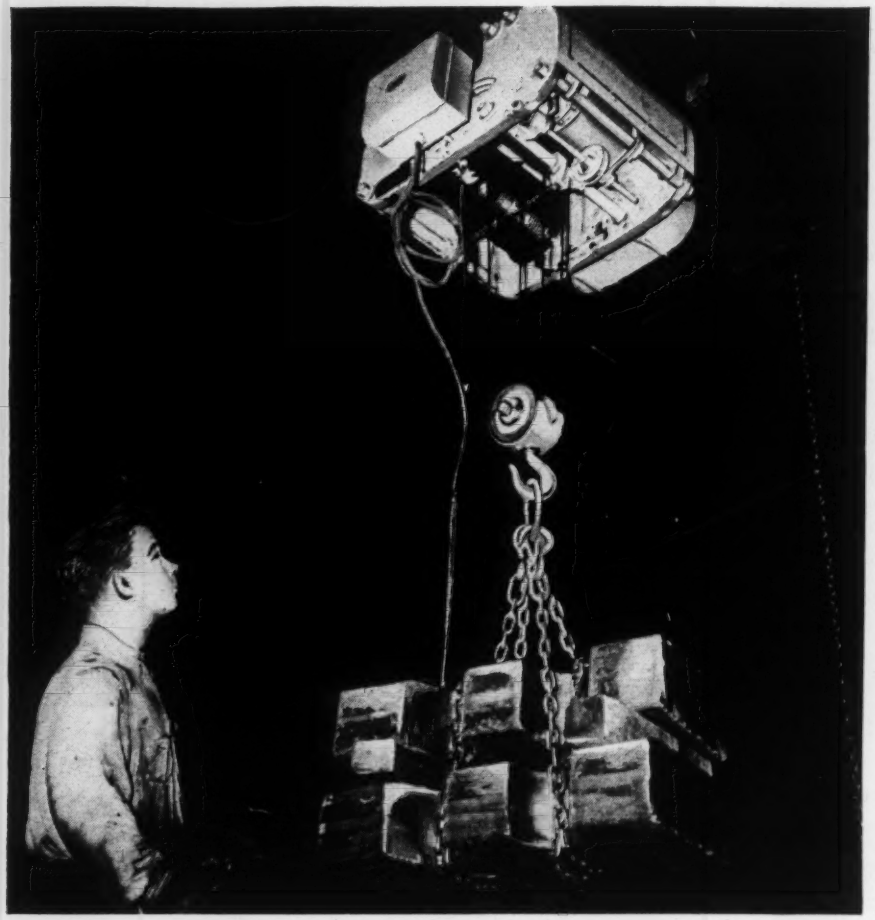
Write for Drawings "A" and "B", showing a wide variety of styles and sizes of Round Frame Cartridge Type Pope Precision Motorized Spindles.



No. 75

POPE
TRADE MARK REG. U.S. PAT. OFF.

POPE MACHINERY CORPORATION
ESTABLISHED 1920
261 RIVER STREET • HAVERHILL, MASSACHUSETTS
BUILDERS OF PRECISION SPINDLES



THIS HARD-WORKING HOIST HANDLES 40-50 TONS A DAY

. . . and a Star-Kimble Brakemotor handles the tough start-stop cycle

[illegible]-ton LO-HED hoist keeps steel moving through a busy forge shop at the rate of 40 to 50 tons a day. And it has kept up the pace since 1945 without a single major repair!

On jobs like this, where the going is tough, American Engineering Co. puts Star-Kimble Brakemotors to work in its hoists, *because . . .*

Star-Kimble Brakemotors have the stamina for heavy day-after-day service, with little or no attention.

They have short travel length between electromagnets and brake armature plate for quick brake release and fast motor *starts*. The hoist *picks* materials *up* in a hurry!

They have big braking area for sure, speedy *stops*. The hoist *puts* materials *down* where they're wanted!

Wherever the application calls for smooth, quick starts and split-second stops—in the toughest of over-and-over again cycles—there is a job for Star-Kimble Brakemotors. Each Brakemotor is an integral unit designed for the application—with motor and brake *built* together to *work* together.

Get the full story—write for free copy of Bulletin B-501-A.

STAR-KIMBLE

MOTOR DIVISION OF

[illegible]EHLE PRINTING PRESS AND MFG. CO.

201 Bloomfield Avenue Bloomfield, New Jersey

SALES NOTES

ESTABLISHMENT of West Coast regional headquarters at 733 East Pico Blvd., Los Angeles, has been announced by the **Bellows Co.**, Akron, O., manufacturer of Controlled-Air-Power devices for industrial use. The new regional headquarters will direct the sales and service activities of Bellows field engineers serving the industrial areas of Los Angeles, San Francisco, Spokane, Portland and Seattle. George Cook, formerly of **Conapco Inc.**, will act as West Coast regional manager. The company will also take over all distribution sales activities for **Smith Johnson Corp.**, Los Angeles, manufacturers of Senacon pneumatic equipment formerly handled by Conapco Inc.

♦

Hanna Engineering Works, Chicago manufacturer of air and hydraulic cylinders and controls, has appointed the **Industrial Air & Hydraulic Equipment Co.**, 13306 Kercheval Ave., Detroit, as exclusive sales representative in Michigan, east of Lake Michigan.

♦

Three branch offices and warehouses of the **Fafnir Bearing Co.**, New Britain, Conn., have been moved to larger, more modern quarters. The Charlotte branch office and warehouse is now located at 119 West 29th St., Charlotte 6, N. C.; the Chicago branch office and warehouse, at 3334 West Newport Ave., Chicago 18, Ill.; and the Cincinnati sales office, at 920 East McMillen St., Cincinnati 6, O.

♦

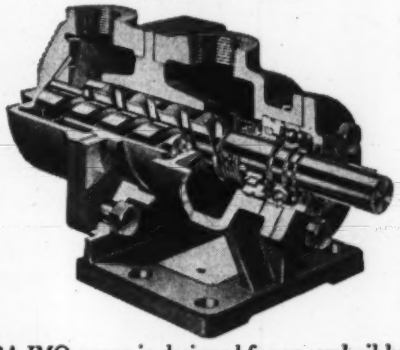
Insulation and Wires Inc., 3435 Chouteau Ave., St. Louis 3, Mo., has been appointed an authorized distributor for insulating materials produced by the chemical department of **General Electric Co.** With twenty-five salesmen located in key industrial areas throughout the country, Insulation and Wires Inc. will handle the following electrical insulating products: Varnished fabrics; mica products including segment, heater, and flexible plate; composite insulation; and G-E Textolite laminated plastics in the form of sheets, tubes and rods. Silicone insulating mate-

build dependability into your product . . .

SPECIFY

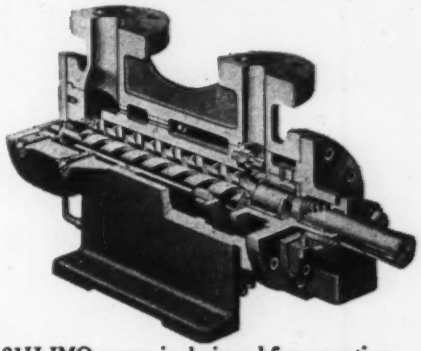
DE LAVAL IMO pumps, gears and couplings

SERIES A313A IMO PUMP



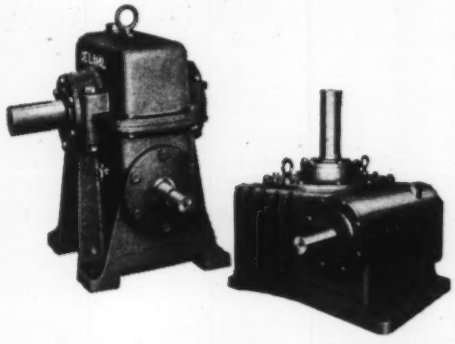
The A313A IMO pump is designed for general oil handling service against medium pressures. Suction connection can be made in any 90° position. Available for capacities to 80 gpm and pressures to 150 psi. For further information, ask for Catalog No. L313A.

SERIES A31H IMO PUMP



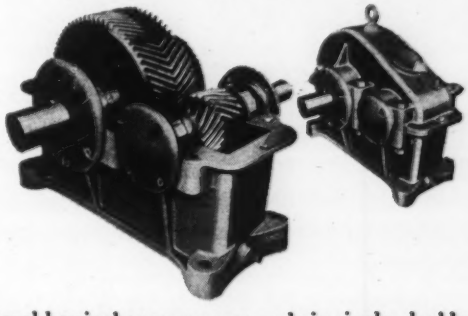
The A31H IMO pump is designed for operation continuously at pressures up to 1000 psi and intermittently at pressures of 1500 psi. The pump is ideally suited to high pressure hydraulic applications. Available for capacities to 150 gpm.

WORM GEAR SPEED REDUCERS



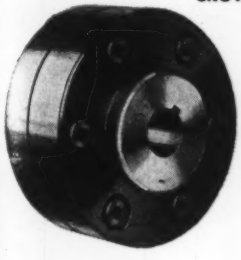
De Laval worm gears are made in horizontal and vertical, single and double reduction units for ratios to 8000: 1 for transmitting up to 250 hp. Write for catalog GWBV.

HERRINGBONE GEAR SPEED REDUCERS



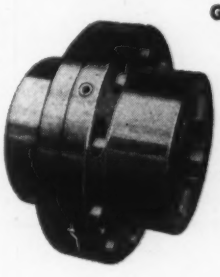
De Laval herringbone gears are made in single, double and triple reduction units for ratios to 318.7:1 for transmitting up to 1015 hp. All units are available with either right or left hand shaft extensions and for torque or overhung load applications. Write for Catalog HHS.

CROWN COUPLING



The unique crowned bolt used in the De Laval Crown Coupling distributes stresses over a greater area than does a straight bolt, resulting in longer life. Standard sizes available up to 11½" bore and 400 hp per 100 rpm. For further information, write for Bulletin 2202.

GEAR COUPLING



In the De Laval gear coupling, dust and moisture are sealed out, lubricant sealed in. The coupling is made of steel throughout. Standard sizes available up to 6⅜" bore and 400 hp per 100 rpm. For further information, write for Bulletin 2201-A.

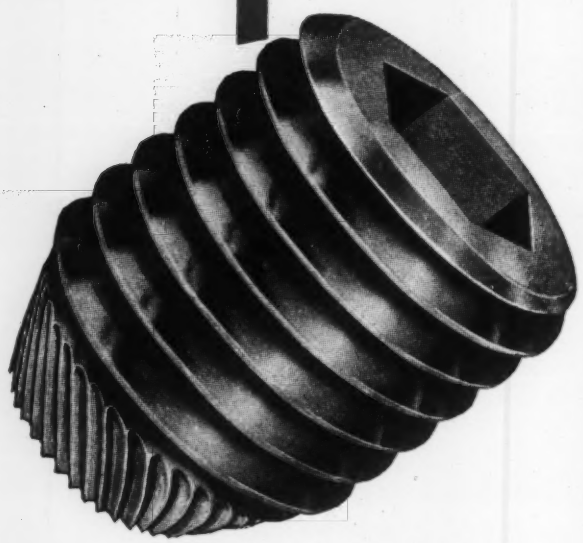
DE LAVAL STEAM TURBINE CO., TRENTON 2, N. J.

IMO-DE LAVAL PRODUCTS DIVISION

50th DE LAVAL Anniversary

G-2

Why UNBRAKO



SPECIFY "STANDARD SIZES"

If you can use *standard sizes* of UNBRAKO Socket Screw Products, we can assure you of *all you want, when you want them!*

Your local UNBRAKO Distributor has full stocks of standard UNBRAKO catalog items on his shelves — ready for immediate delivery.

But "**specials**" are another story. Due to shortages and increased demand, deliveries are unpredictable, costs prohibitive.

And in many cases we find that "specials" are so close to the borderline that "standards" could easily be adapted.

So why not have your requirements re-checked? There may be many places where UNBRAKO "standards" could be used to advantage. If you wish, our "fastener engineers" will be glad to make recommendations. No obligation, of course.

And if you don't have our latest catalog
— write for Bulletin 643-R

FOR FASTER UNINTERRUPTED PRODUCTION

KNURLING OF SOCKET SCREWS ORIGINATED WITH "UNBRAKO" IN 1934

Knurled Socket Head Cap Screw | Flat Head Socket Cap Screw | Knurled Point Socket Set Screw | Knurled Socket Head Shoulder Screw | Fully-Formed Pressure Plug | Precision-Ground Dowel Pin

-SPS STANDARD PRESSED STEEL CO.

JENKINTOWN 18, PENNSYLVANIA

rials for Class H electric insulation will also be handled.

♦

Kennametal Inc., Latrobe, Pa., manufacturer of cemented carbide products, has opened a district office in the Metropolitan Bldg., Minneapolis. Harry Brandvik, formerly a service engineer in the Midwestern district, is the representative at this office.

♦

Two developments of particular interest to the oil industry took place in January and concerned **Tube Turns Inc.**, Louisville, Ky., **Bethlehem Supply Co. of California**, and **Bethlehem Supply Co.**, Tulsa, Okla. The Bethlehem Supply Co. of California now operates as an integral unit of the Tulsa organization. The merger was made public following a recent announcement that Bethlehem Supply Co. and the Bethlehem Supply Co. of California had been appointed authorized distributors of Tube-Turn welding fittings and flanges in the oil country.

♦

The **Whitney Chain Co.** of Hartford, Conn., has opened its new office and warehouse building located at 5400 Pacific Blvd., Los Angeles, Calif. Under the direction of A. J. Swisler, district manager, the modern headquarters will function as the engineering sales and service outlet for the complete line of Whitney power transmission and conveying chain, couplings, keys and sprockets throughout southern California and Arizona, with facilities for giving emergency service to all Pacific Coast points.

♦

Telechron Inc. has announced the opening of an industrial sales office at 416 Schmidt Bldg., 431 Main St., Cincinnati 2, O., to serve customers in the mid-central area, including Michigan, Ohio, eastern Indiana, western Pennsylvania, Tennessee and Kentucky. R. H. LeShane, who formerly made his headquarters in Cleveland, is the district representative.

♦

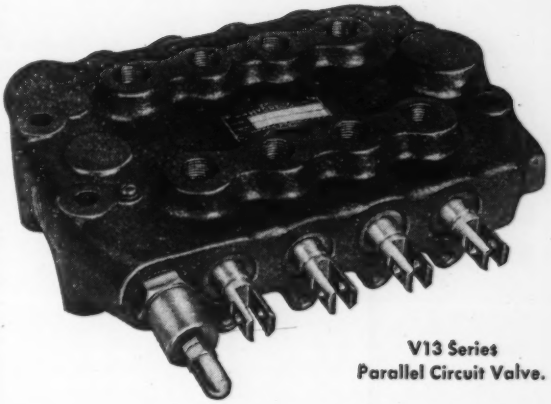
A new development service to provide corrosion and abrasion resistant finishes for industrial products is being announced by the **Erie Enameling Co.**, Erie, Pa. Porcelain enamelers for the past twenty-five years, the firm is inaugurating this service because of increasing demand for high durability finishes on hundreds of different industrial products and equipment parts. Among products which are currently being finished in special

The "Labor-Saving"
SHERMAN POWER DIGGER
is equipped with
HYDRECO
OIL HYDRAULIC CONTROLS

Sherman Power Diggers, designed and manufactured jointly by Sherman Products Incorporated and Wain-Roy Corporation, make full use of the power, control and dependability of HYDRECO Pumps, Valves and Cylinders in an ingenious labor-saving machine.

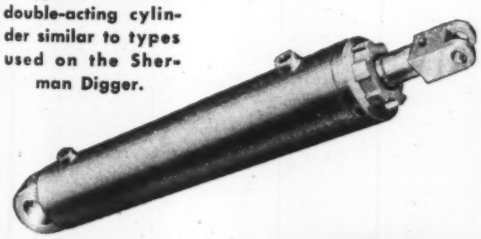
HYDRECO Parallel Circuit Valve Units provide multiple operation for crowding, lifting and bucket control during certain phases of the digging cycle. Jerky motion is entirely eliminated and the operator can count on *fast* and *smooth* operations all the time.

HYDRECO *Flow Control* and *Cushion Relief* Valves, which keep the shovel and boom under complete control, assure *safety* for both operator and machine.



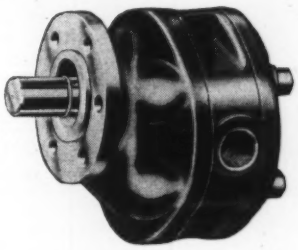
V13 Series Parallel Circuit Valve.

A typical HYDRECO double-acting cylinder similar to types used on the Sherman Digger.



All hydraulic cylinders on the Power Digger are HYDRECO built and designed for digging operations in all kinds of ground and materials and under all conditions. Efficient rod wipers and cylinder packings *keep oil in and dirt out* of the hydraulic system.

A HYDRECO 2000 Series Four-Bolt Pump.

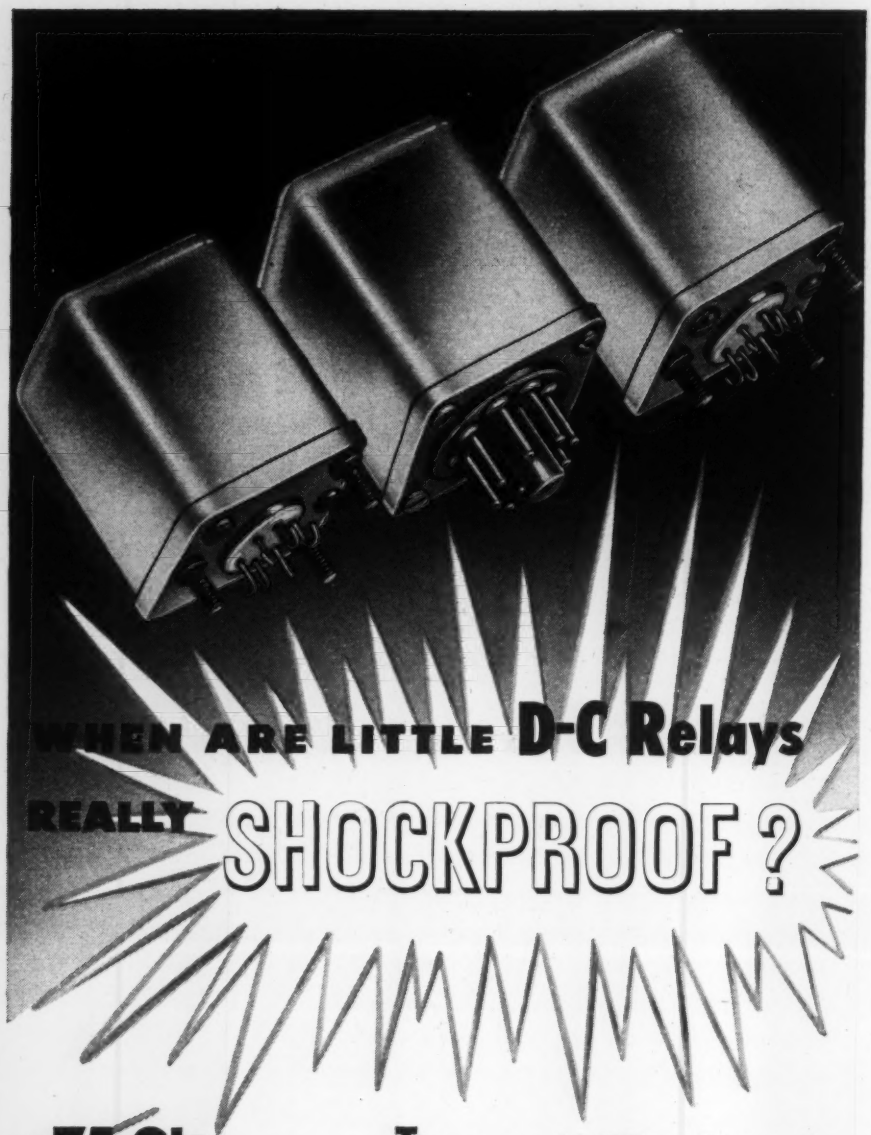


Dependable and efficient hydraulic power is furnished by a HYDRECO Four-Bolt Gear-Type Pump that is directly connected to the engine of the Power Digger.

Build more profitable Labor-Saving
into your equipment
with HYDRECO controls

HYDRECO
HYDRAULIC CONTROL DEVICES
PUMPS · CYLINDERS · VALVES

HYDRAULIC EQUIPMENT COMPANY
1106 EAST 222nd STREET • CLEVELAND 17, OHIO



WHEN ARE LITTLE D-C Relays REALLY SHOCKPROOF?

75 G's MECHANICAL SHOCK

25 G's OPERATING SHOCK

15 G's VIBRATION

The answer is "When they perform dependably under the conditions of shock and vibration for which they are recommended."

That means you can safely use these little multipole d-c relays on a wide variety of portable, mobile, aircraft, ship and commercial applications where shock does not exceed the exceptionally broad limits indicated at the left. *Write for Struthers-Dunn Data Bulletin 2610.*

STRUTHERS-DUNN

5,348 RELAY TYPES

STRUTHERS-DUNN, INC., 150 N. 13th ST., PHILADELPHIA 7, PA.

BALTIMORE • BOSTON • BUFFALO • CHARLOTTE • CHICAGO • CINCINNATI
CLEVELAND • DALLAS • DETROIT • KANSAS CITY • LOS ANGELES
MINNEAPOLIS • MONTREAL • NEW ORLEANS • NEW YORK • PITTSBURGH
ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO

types of industrial porcelain enamel are piping, fittings and valves for use in synthetic rubber manufacture, exhaust mufflers, furnace saggers, pickling and heat treating equipment parts, conveyor buckets and idler rollers, various types of chutes, pump parts and many other items.

♦

Joseph T. Ryerson & Son Inc. has been appointed exclusive warehouse distributor of Rockrite tubing, manufactured by the **Tube Reducing Corp.,** Wallington, N. J. Rockrite tubing is manufactured by a special cold-sizing process as contrasted to the cold drawing method used in the manufacture of standard commercial quality cold drawn seamless tubing. A comprehensive range of sizes of Rockrite tubing, for hydraulic cylinder applications, is now carried in Ryerson warehouse stocks.

♦

Because of war-caused difficulties, a new division of **Reinecke and Associates,** Chicago industrial design firm, has been established to advise clients on the availability of critical materials and the possibility of shifting to substitutes. Assigned to handle this research is Donald B. Lowe, one of the firm's designers. He has been in charge of material investigation in the past, concentrating on specifications, costs, and production methods.

♦

Announcement has been made by the **Rigidized Metals Corp.,** manufacturer of design-strengthened and textured three-dimensional metals, of the appointment of three new sales representatives as follows: **Robert J. Wagner,** 1390 Westwood Blvd., Los Angeles, Calif., whose territory includes the West Coast, Washington, Oregon and California; the **Disque Steel Products Co.,** 824 Board of Trade Bldg., Indianapolis 4, Ind., covering the state of Indiana; and the **Adler Steel Products Co.,** 408-9 Thorpe Bldg., Minneapolis 2, Minn., representing Rigidized Metals Corp. in the state of Minnesota.

♦

The **Eriez Manufacturing Co.,** Erie, Pa., has announced the appointment of **C. D. Sutton Inc.** as the Eriez representative in the Los Angeles area, handling the complete Eriez line, which includes all permanent magnetic separation equipment of its own manufacture, Memco electromagnetic separation equipment and RCA electronic metal detectors. Complete research and laboratory facilities on both permanent and electromagnetic separation equipment will be made available through C. D. Sutton Inc. This is possible through the

You might ponder a bit about what you see in Soda Fountains

UNLIKE the bemused young man who is ruining his shoeshine, above, we ask you to overlook the social aspects of soda fountains, sandwich shops or lunch counters, etc., and give heed instead to their economics.

The economic angles, for instance, that cause these popular eating places of the short-order, quick-lunch variety to go in so heavily for stainless steel equipment. Notice it for yourself. Practically *everything* behind their counters is made of clean, bright, efficient-looking stainless steel—sometimes even the walls and ceiling.

Why? Because nothing else fills the bill as well and keeps operating costs as low. No other commercially available metal packs the same combination of great strength and resistance to corrosion, heat and wear.

If these properties are important to soda fountains, they are doubly vital to essential industries and to the national welfare in times of stress.

Every user of stainless steel today should aim at using it to the best advantage. ● We're ready to help you, and in addition we're continuing to spend millions of dollars to increase the supply of Allegheny Metal and other alloy products.

* * * * *

Complete technical and fabricating data—engineering help, too—are yours for the asking from Allegheny Ludlum Steel Corporation, Pittsburgh, Pa. . . . the nation's leading producer of stainless steel in all forms. Branch Offices are located in principal cities, coast to coast, and Warehouse Stocks of Allegheny Stainless Steel are carried by all Joseph T. Ryerson & Son, Inc. plants.

WAD 3262

You can make it **BETTER** with

Allegheny Metal

AL
TIME-TESTED STAINLESS STEEL

How's this for STRENGTH?

SUPER ACE GRADE—one of the many formulas of Ace Hard Rubber available for molded and extruded machine parts, has a tensile strength exceeding that of most plastics, and high impact strength, too!

Even more important than strength is the *durability* of hard rubber—its unusual toughness, high abrasion-resistance, excellent resistance to water, acids, alkalies, etc. Only glass-bonded mica has lower moisture absorption.

For instance: the accuracy of water meters depends on strength, long-life, and stability of the hard rubber parts—expected to last 10—even 20—years under water. Here fatigue resistance is vital, as the parts may go through 50,000,000 or more cycles in a lifetime.

With many different Ace Hard Rubber molding compounds, sheets, rods and tubes to choose from—also other Ace plastics such as Ace-Tex, Parian, Saran—you can select just the right combination of technical properties. And with our complete molding, extruding and fabricating facilities (among the world's largest) at your service, your job will be done the best way, the quickest.

Always check your Ace Handbook, pgs. 4 and 5, when selecting molding materials. If you haven't a copy of this valuable 60-pg. manual, *write today—it's free.*

ACE
Since 1851

HARD RUBBER and PLASTICS

AMERICAN HARD RUBBER COMPANY

11 MERCER STREET • NEW YORK 13, N. Y.

co-operation of the Eriez and Memco organizations, both pioneers in magnetic separation.

♦

The appointment of **Joseph H. Bertram & Co.** as sales representative covering all of New England except Connecticut has been announced by **Kieley & Mueller,** industrial control valve manufacturer of North Bergen, N. J. This appointment became effective February 1, coincident with the opening of new offices at 209 Washington St., Boston, Mass.

♦

Wheelco Instruments Co., Chicago, has announced the appointment of **Ansell & Goda** as district agency for the territory which includes the District of Columbia, Virginia and part of Maryland. The agency has opened a new office at 3432 Connecticut Ave., N.W., Washington 8, D. C. The former agents in this territory, the **Phipps & Bird Co.,** will continue to serve as an authorized resale agency of the Wheelco Instruments Co.

♦

The name of Drafting Associates Inc. has been changed to **Bristol Engineering Corp.** in order to coincide with expanding activities in providing engineering, drafting and related technical services.

♦

Conoflow Corp., Philadelphia manufacturer of pneumatic control accessory equipment, has announced the appointment of **J. R. Simpson and Co.,** 600 South Michigan Ave., Chicago, as Conoflow representatives. In addition to the Chicago area, the Simpson company, headed by J. Robert Simpson Jr., will operate in Illinois, Indiana, and Wisconsin. Bringing with him a wealth of experience in the industrial control field, Mr. Simpson will be engaged in the application, engineering and selling of Conoflow control equipment to the process and heavy industries.

♦

The **Black & Decker Mfg. Co.** has opened a large new sales and service branch at 881 West Delavan Ave., Buffalo 9, N. Y. The new building covers over 4100 sq ft and increases sales and service facilities nearly 400 per cent over the company's previous location at 17 East Utica St.

♦

The branch office of the **Century Electric Co.** has been moved from Rochester, N. Y. to 814 Syracuse-Kemper Bldg., 224 Harrison St., Syracuse, N. Y. Lloyd H. Downing, district sales manager of the company, is in charge of the new office.

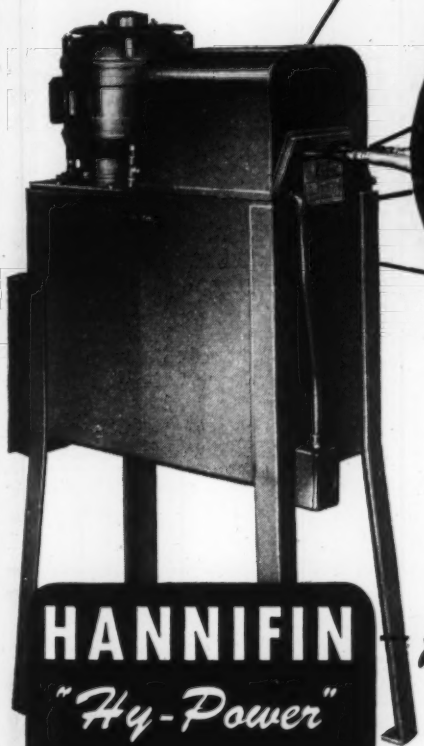
With these Tools One Man Can Do More Work!

PUNCHING—7½-ton Hannifin "Hy-Power" Portable Punch used in the assembly of light gauge sheet metal structures.

RIVETING—Fabricating steel furnace sections with 25-ton Hannifin "Hy-Power" Portable Hydraulic Riveter.

RIVETING—35-Ton "Hy-Power" Portable Riveter used in assembling heavy truck trailer frames.

PRESSING—7½-Ton Portable "Hy-Power" Press used in pressing timing gears on automobile engine crankshafts on conveyor assembly lines.



HANNIFIN "Hy-Power" HYDRAULIC Power Units

— *plus* TOOLS that anyone can operate!

HERE is a combination that can't be beat! Hannifin "Hy-Power" hydraulic units quickly pay for themselves in even small production shops. In any plant, they enable a man to handle almost unbelievably large volumes of work with a minimum outlay for equipment and floor space. A most important advantage is that anyone can operate them and, without any special skill or experience, turn out perfect work hour after hour at peak speed. Physical effort needed to handle balanced tools is negligible. Work performed by different operators is always uniform.

Hannifin supplies everything you need—complete units designed to meet your particular requirements, or power units and cylinders for use in machines of your own design. Today, in thousands of installations throughout the world, production engineers and tool designers are using Hannifin "Hy-Power" Hydraulic equipment as the key to better, faster production and lower costs for an almost unlimited range of applications! You, too, can benefit from this equipment. *For complete information, see your local Hannifin representative, or write.*

"Hy-Power Hydraulics"—ASK for a copy of this 28 page illustrated Bulletin No. 150 for Tool Designers and Production Engineers.

HANNIFIN CORPORATION

1115 South Kilbourn Avenue • Chicago 24, Illinois

AIR CYLINDERS • HYDRAULIC CYLINDERS • HYDRAULIC PRESSES
PNEUMATIC PRESSES • HYDRAULIC RIVETERS • AIR CONTROL VALVES

PUMPS

FOR COOLANTS, LUBRICANTS, AND ABRASIVE LIQUIDS

PUMPS

POSITIVE DISPLACEMENT AND IMPELLER TYPES

PUMPS

J. I. C. STANDARDS OR DIRECT MOTOR CONNECTED

PUMPS

FOR TWENTY YEARS—DEPENDABLE, ECONOMICAL, EFFICIENT

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PIONEER PUMP

& MANUFACTURING CO., INC.

STANDARD OR SPECIAL, FOR EVERY MACHINE TOOL AND INDUSTRIAL USE

19652 JOHN R STREET
DETROIT 3, MICHIGAN

WRITE FOR CATALOG

MEETINGS

AND EXPOSITIONS

Mar. 15-17—

American Society of Tool Engineers. Annual meeting to be held at the Hotel New Yorker, New York, N. Y. Additional information may be obtained from society headquarters, 10700 Puritan Ave., Detroit 26.

Mar. 16—

Institute of the Aeronautical Sciences. Sixth annual flight propulsion meeting to be held at the Hotel Carter, Cleveland, Ohio. R. R. Dexter, 2 East 64th St., New York 21, N. Y., is secretary.

Mar. 19-23—

American Society for Metals. Western metal congress and exposition to be held in the Civic Auditorium, Oakland, Calif. William H. Eisenman, 7301 Euclid Ave., Cleveland 3, Ohio, is national secretary.

Apr. 2-5—

American Society of Mechanical Engineers. Spring meeting to be held at Hotel Atlanta-Biltmore, Atlanta, Ga. C. E. Davies, 29 West 39th St., New York 17, N. Y., is secretary.

Apr. 4-6—

Midwest Power Conference sponsored by the Illinois Institute of Technology to be held at the Sherman Hotel, Chicago, Ill. Additional information may be obtained from Dr. R. A. Budenholzer, Director of the Conference, 3300 South Dearborn St., Chicago 16, Ill.

Apr. 16—

Packaging Machinery Manufacturers Institute. Semi-annual meeting to be held at the Hotel Dennis, Atlantic City, N. J. Additional information may be obtained from society headquarters, 342 Madison Ave., New York 17, N. Y.

April 16-18—

Society of Automotive Engineers. Aeronautic and aircraft engine display meeting to be held at the Statler Hotel, New York. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

Apr. 16-18—

American Society of Lubrication Engineers. National convention to be

BOSTON Gear STOCKS ARE Here

at factory prices

Save time and money—assure yourself of uniform quality and parts interchangeability by standardizing on Boston Gear quality products—stocked at these Authorized Boston Gear Distributors — one near you!

AKRON, OHIO
Bearing Distributors, Inc.
280 E. Exchange St.
ALBANY, NEW YORK
Sager-Spuck Sup. Co.
364-366 Broadway
ALLENTOWN, PENNSYLVANIA
Wm. H. Taylor & Co., Inc.
230-256 Hamilton St.
ATLANTA, GEORGIA
J. M. Tull Metal & Sup. Co.
285 Marietta St.
BALTIMORE, MARYLAND
Carey Mchy. & Sup. Co.
3501 Brehm's Lane
BIRMINGHAM, ALABAMA
Owen-Richards Co., Inc.
1009 2nd Ave. N.
BOSTON, MASSACHUSETTS
Chandler & Farquhar, Inc.
900 Commonwealth Ave.
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Hawley Hardware Co.
1120 Main St.
BROOKLYN, NEW YORK
H. L. Dickie
314-36th St.
BUFFALO, NEW YORK
Root, Neal & Co.
64 Peabody St.
CHARLOTTE, NORTH CAROLINA
Matthews-Morse Sales Co.
909 S. Mint St.
CHICAGO, ILLINOIS
Boston Gear Works
955 W. Washington Blvd.
Chgo. Pulley & Shafting Co.
23 N. Desplaines St.
Samuel Harris & Co.
114-116 N. Clinton St.
Power Trans. Equip. Co.
1245 W. Fulton St.
CINCINNATI, OHIO
Queen City Sup. Co.
Pearl & Elm Sts.
CLEVELAND, OHIO
Bearing Distributors, Inc.
2618 Carnegie Ave.
Boston Gear Works
211 St. Clair Ave., N. W.
Mau-Sherwood Sup. Co.
800 Lime Road
COLUMBUS, OHIO
Ohio Trans. Co.
666 Parsons Ave.
DALLAS, TEXAS
Geo. J. Fix Co.
2413-15 Commerce St.
DAYTON, OHIO
Klinger-Dills
1041 So. Patterson Blvd.
DENVER, COLORADO
Western Belting & Packing Co.
1720-28 Wazee St.
DES MOINES, IOWA
Standard Bearings Co.
1014 Grand Ave.
DETROIT, MICHIGAN
Chas. A. Strelinger Co.
149-165 E. Larned St.
EVANSVILLE, INDIANA
Bearings Service Co., Inc.
9 N. W. First St.
GREENSBORO, NORTH CAROLINA
Trans. Supplies, Inc.
403 Walker Ave.
HAMILTON, ONTARIO
Renold-Coventry, Ltd.
443 King St. E.
HARTFORD, CONNECTICUT
Sillitor-Holden, Inc.
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HOUSTON, TEXAS
Geo. J. Fix Co.
2702 Polk Ave.
INDIANAPOLIS, INDIANA
Vonnegut Hardware Co.
402 W. Maryland St.
JACKSONVILLE, FLORIDA
S. B. Hubbard Co.
32 W. Bay St.
KANSAS CITY, MISSOURI
Elliefelt Mchy. & Sup. Co.
1219 McGee St.
KNOXVILLE, TENNESSEE
Hoyt N. Payne Co.
410 E. Depot Ave.
LANCASTER, PENNSYLVANIA
Herr & Co., Inc.
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LONDON, ONTARIO
Renold-Coventry, Ltd.
277 Piccadilly
LONG ISLAND CITY, NEW YORK
L. C. Biglow & Co., Inc.
11-06 Jackson Ave.
LOS ANGELES, CALIFORNIA
Andrews Hardware & Metal Co.
334 S. Main St.
Garrett Supply Co.
3844 S. Santa Fe Ave.
LOUISVILLE, KENTUCKY
Industrial Equip. Co.
7th & Myrtle Sts.
MEMPHIS, TENNESSEE
Lewis Sup. Co.
Main at Butler Sts.
MIAMI, FLORIDA
Gondas Corp.
2140-50 N. Miami Ave.
MILWAUKEE, WISCONSIN
Western Iron Stores Co.
319-331 East Clybourn St.
Wisconsin Bearing Co.
915-917 N. Market St.
MINNEAPOLIS, MINNESOTA
R. C. Duncan Co., 1300 4th St. S.
MONTREAL, QUEBEC
Renold-Coventry, Ltd.
1006 Mountain St.
NEWARK, NEW JERSEY
Squier, Schilling & Skiff
419 Plane St.
NEW ORLEANS, LOUISIANA
McLellan A-C Sup. Co.
2375 Tchoupitoulas St.
NEW YORK, NEW YORK
L. C. Biglow & Co., Inc.
250 W. 54th St.
Boston Gear Works, 480 Canal St.
Frank Tracy, Inc., 202 Centre St.
OAKLAND, CALIFORNIA
C. W. Marwedel
11th & Alice Sts.
PHILADELPHIA, PENNSYLVANIA
Boston Gear Works
Broad St. Cor. of Lycoming & 16th Sts.
Lindsay, Oberholzer & Co.
4432 Ridge Ave.
Maddock & Company
42 N. Sixth St.
PITTSBURGH, PENNSYLVANIA
Somers, Fitler & Todd Co.
313-327 Water Street
PORTLAND, OREGON
Woodbury & Co.
133 S. W. 2nd Ave.
PROVIDENCE, RHODE ISLAND
Machine Parts Corp.
271 Washington St.
QUEBEC, QUEBEC
Renold-Coventry, Ltd.
5 Bourlamaque Ave.
QUINCY, MASSACHUSETTS
Boston Gear Works
14 Hayward St.
RICHMOND, VIRGINIA
Industrial Sup. Co.
15th & Franklin Sts.
ROCHESTER, NEW YORK
John M. Forstar Co.
110 Mill St.
ST. LOUIS, MISSOURI
Colcord-Wright Mchy. & Sup. Co.
1223-1229 N. Broadway
SAN FRANCISCO, CALIFORNIA
Boston Gear Works
123 10th St.
C. W. Marwedel
1235 Mission St.
SEATTLE, WASHINGTON
Cragin & Co.
932 First Ave. S.
SPRINGFIELD, MASSACHUSETTS
Boston Gear Works
29 Worthington St.
SYRACUSE, NEW YORK
Syracuse Sup. Co.
314 W. Fayette St.
TAMPA, FLORIDA
Southern Pump & Sup., Inc.
902 Twiggs St.
TOLEDO, OHIO
Ohio Belting & Trans. Co.
406 Orange St.
TORONTO, ONTARIO
Renold-Coventry, Ltd.
50 Edward St.
TRENTON, NEW JERSEY
Wiley-Hughes Sup. Co.
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Renold-Coventry, Ltd.
1066 Seymour St.
WATERBURY, CONNECTICUT
White Supply Co.
297 Thomaston Ave.
WILKES-BARRE, PENNSYLVANIA
Malmes Metallic Co.
519-521 S. Main St.
WINSTON-SALEM, NORTH CAROLINA
Koster Machinery Co.
300 E. 3rd St.
WORCESTER, MASSACHUSETTS
W. M. Steele Co.
171 Fremont St.

BOSTON Gear STOCKS ARE Near

CASE NO. 1

MULTI-SPINDLE AUTOMATIC CHUCKING MACHINE

A cheap gear gave out — was replaced by a BOSTON Gear. Net difference in cost between a BOSTON Gear and a cheap gear	$ 0.80 "saved"
Cost of repairing machine (two men, 9 hrs.) @ $1.80 per hr. per man	32.40 lost
Loss of profit through loss of 9 hours production — — 40 pieces per hour x $1.25 per piece x 9	450.00 lost
NET LOSS	$481.60

(To say nothing of the re-scheduling headaches involved)

CASE NO. 2

GEAR DRIVEN OIL PUMP ON AN AUTOMATIC SCREW MACHINE

A cheap gear driving the pump failed and was replaced by a Standardized BOSTON Gear. Net difference in cost between a BOSTON Gear and a cheap gear	$ 0.35 "saved"
Cost of repairing machine (one man, 1½ hrs.) @ $1.80 per hour	2.70 lost
Loss of profit through loss of 3 hours production — — 50 pieces per hour x $0.95 per piece x 3	142.50 lost
NET LOSS	$144.85

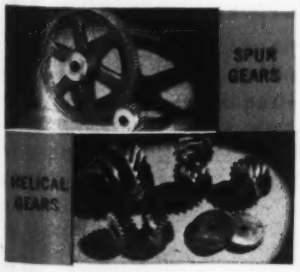
HOW *Cheap* IS A *Cheap* GEAR?

Sure, you can shop around and buy gears for a few cents less than STANDARDIZED *Boston Gears* — gears of known quality and proved performance.

But, stop and think what this "saving" really means. The purchase price of the gear is a tiny fraction of the cost of replacing a gear.

Look at these typical examples. They're not exaggerated. You can think of many like them.

Gears of inferior quality not only wear out faster, requiring more frequent replacement, but they're noisier, waste power, cause frequent bearing replacement...With gears it pays to standardize on the best — in design, material, workmanship, finish, accuracy — *BOSTON Gears.*

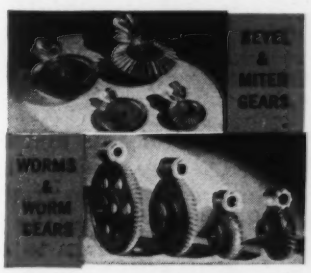


SPECIFY STANDARDIZED BOSTON GEARS

DESIGN THEM INTO YOUR EQUIPMENT

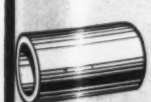
GET THEM FROM NEARBY STOCK

(See list of Authorized Boston Gear Distributors)



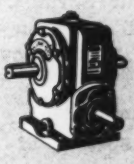
BOSTON GEAR WORKS

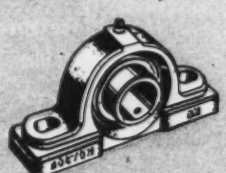
64 HAYWARD ST., QUINCY 71, MASS.

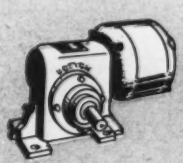

Bost-Bronz Bearings

Universal Joints

Sprocket and Chain


Reductors

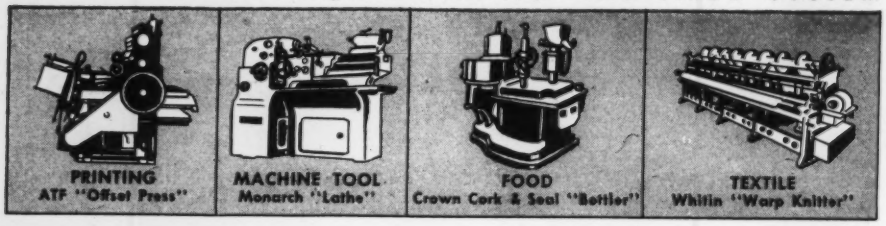

Pillow Blocks


Ratiomotors

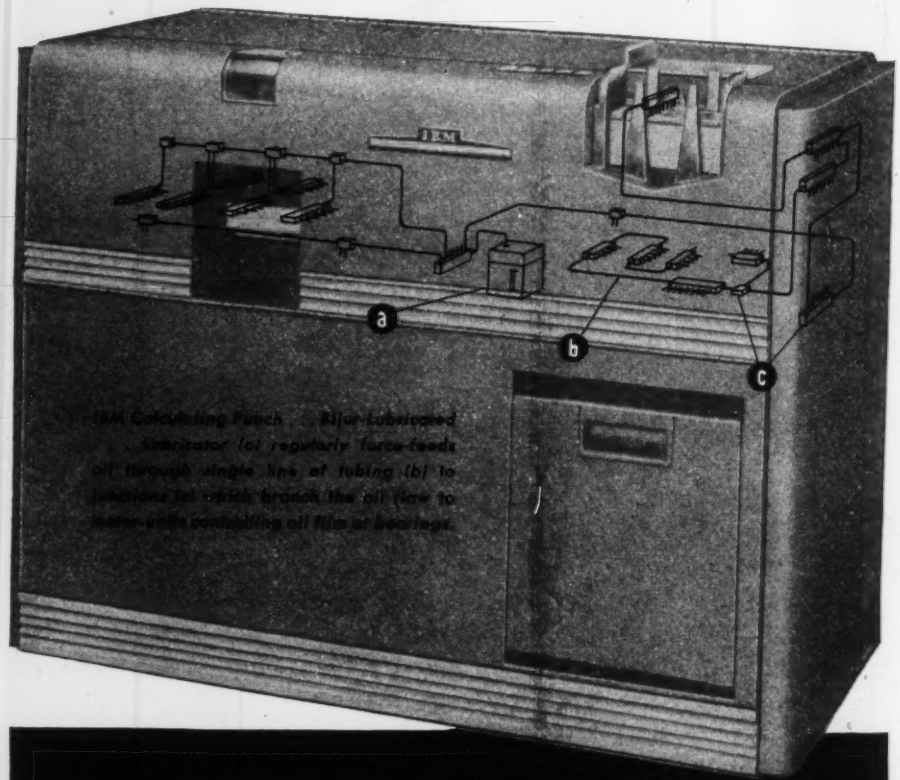
Bearings

Couplings

LEADING MANUFACTURERS UTILIZE THE BIJUR SYSTEM



built-in protection



IBM Calculating Punch . . . Bijur-Lubricated lubricator (a) regularly force-feeds oil through single line of tubing (b) to junctions (c) which branch the oil flow to meter-units controlling oil film at bearings.

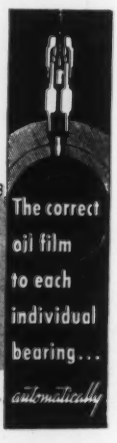
over 100 bearings lubricated...automatically

All 109 bearings of this machine must be oiled at once *during operation* to maintain continuous production. The Bijur system does the job by connecting all bearings to one lubricator, driven by the machine.

No sign of a system is seen outside the machine as it is completely built in at time of manufacture. This makes for a compact internal design and a clean-lined exterior.

All bearings are oiled at once, yet each one receives individual attention from Bijur, the system with positive Meter-Unit control of oil flow *at the bearings.*

For further details write for "The ABC of Modern Lubrication."



388

BIJUR
LUBRICATING CORPORATION

ROCHELLE PARK, NEW JERSEY

held at the Bellevue-Stratford Hote Philadelphia, Pa. W. F. Leonard, 3 South Dearborn St., Chicago, 4, Il is secretary.

Apr. 17-20—

American Management Associatio The 20th national packaging expos tion to be held in the Atlantic Cit Auditorium, Atlantic City, N. J. A ditional information may be obtaine from society headquarters, 330 We 42nd St., New York 18, N. Y.

Apr. 23-26—

American Foundrymen's Societ The 55th annual convention to b held in Buffalo, N. Y. Additional in formation may be obtained from s ciety headquarters, 616 S. Michiga Ave., Chicago, Ill.

Apr. 25-26—

Metal Powder Association. Seventh annual meeting to be held at Hote Cleveland, Cleveland, Ohio. Additiona information may be obtained fro society headquarters, 420 Lexingto Ave., New York 17, N. Y.

Apr. 30-May 4—

Materials Handling Exposition t be held in the International Amphi theatre, Chicago, Ill. Additional in formation may be obtained fro Clapp and Poliak, Inc., 341 Madiso Ave., New York 17, N. Y.

Apr. 30-May 11—

British Industries Fair to be hel at Olympia and Earls Court, Londo and at Castle Bromwich, Birming ham, England. Additional informa tion may be obtained from Britis Information Services, 30 Rockefelle Plaza, New York 20, N. Y.

May 23-24—

American Society for Quality Con trol. Fifth annual convention to b held at the Hotel Cleveland, Cleve land, Ohio. Additional informatio may be obtained from society head quarters, 22 East 40th St., New Yor 16, N. Y.

May 24-25—

Society of the Plastic Industry Annual national meeting to be hel at the Greenbrier Hotel, White Su phur Springs, W. Va. W. T. Crus 295 Madison Ave., New York 1 N. Y., is executive vice president.

June 3-8—

Society of Automotive Engineer Summer meeting to be held at th French Lick Springs Hotel, Fren

Lick, Ind. John A. C. Warner, 29, West 39th St., New York 18, N. Y., is secretary and general manager.

June 11-15—

American Society of Mechanical Engineers. Semiannual meeting to be held at the Hotel Royal York, Toronto, Ontario, Canada. C. E. Davies, 29 West 39th St., New York 18, N. Y., is secretary.

June 11-16—

National Congress of Applied Mechanics to be held at Illinois Institute of Technology, Chicago, Ill., under the sponsorship of the ASME, ASCE, AIChE, AMS, APS, IAS, SESA, U. S. National Committee on Theoretical and Applied Mechanics, Illinois Tech, Purdue University, Northwestern University and University of Illinois. Lloyd H. Donnell, Illinois Institute of Technology, 3300 South Federal St., Chicago 16, Ill., is general chairman.

June 15-30—

Seattle International Japanese Trade Fair to be held in the Edmundson Pavilion, Seattle, Wash. Additional information may be obtained from John M. Haydon, Promotion Committee, c/o Port of Seattle, P. O. Box 1878, Seattle 11, Wash.

June 18-22—

American Society for Testing Materials. Annual meeting to be held at the Chalfonte-Haddon Hall, Atlantic City, N. J. Additional information may be obtained from society headquarters, 1916 Race St., Philadelphia 3, Pa.

June 25-29—

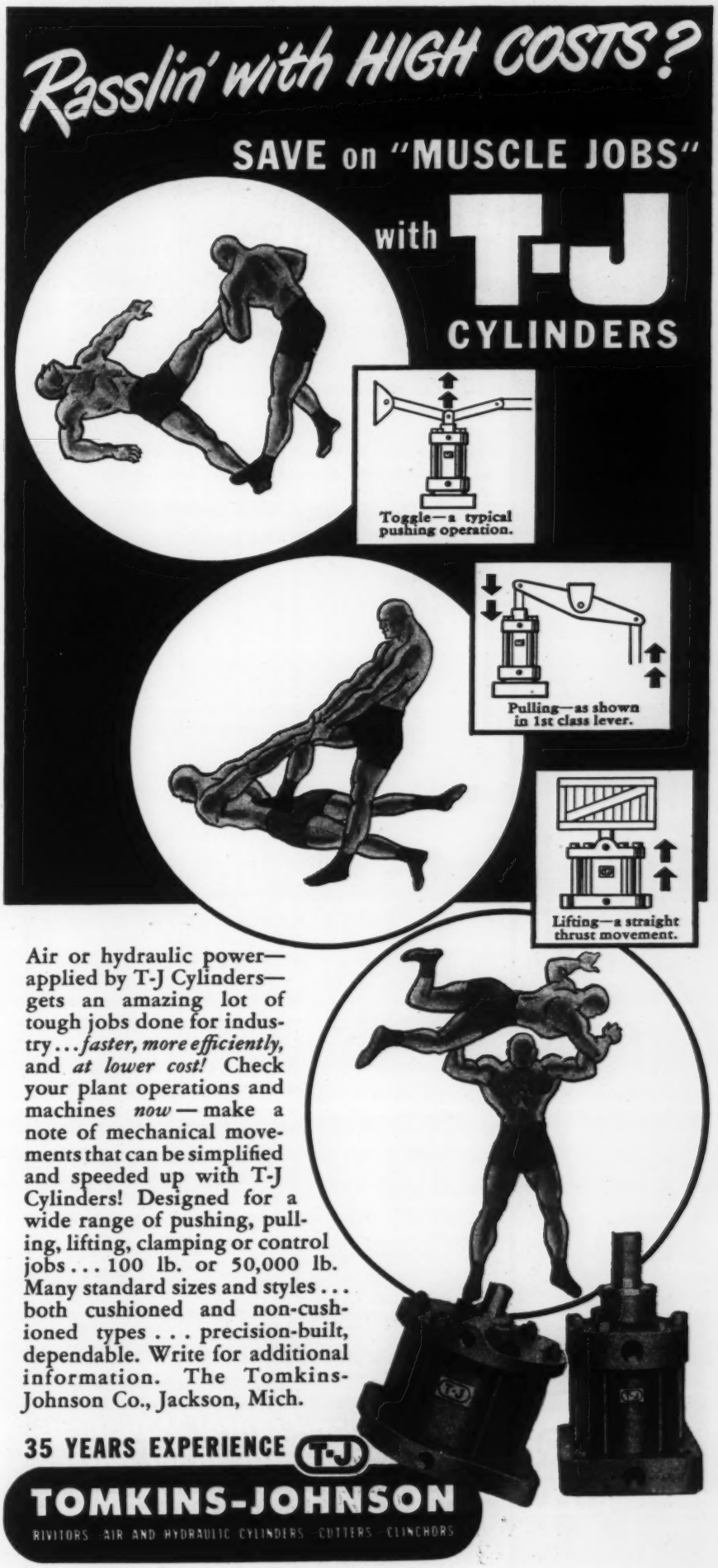
American Institute of Electrical Engineers. Summer general meeting to be held at the Royal York Hotel, Toronto, Ontario, Canada. H. H. Henline, 33 West 39th St., New York 18, N. Y., is secretary.

Aug. 13-15—

Society of Automotive Engineers. West Coast meeting to be held at the Olympic Hotel, Seattle, Wash. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

Sept. 10-13—

Society of Automotive Engineers. Tractor and production forum to be held at the Biltmore Hotel, Los Angeles, Calif. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.


Rasslin' with HIGH COSTS?
SAVE on "MUSCLE JOBS"
with T-J CYLINDERS
Toggle—a typical pushing operation.
Pulling—as shown in 1st class lever.
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Air or hydraulic power—applied by T-J Cylinders—gets an amazing lot of tough jobs done for industry... faster, more efficiently, and at lower cost! Check your plant operations and machines now — make a note of mechanical movements that can be simplified and speeded up with T-J Cylinders! Designed for a wide range of pushing, pulling, lifting, clamping or control jobs... 100 lb. or 50,000 lb. Many standard sizes and styles... both cushioned and non-cushioned types... precision-built, dependable. Write for additional information. The Tomkins-Johnson Co., Jackson, Mich.
35 YEARS EXPERIENCE
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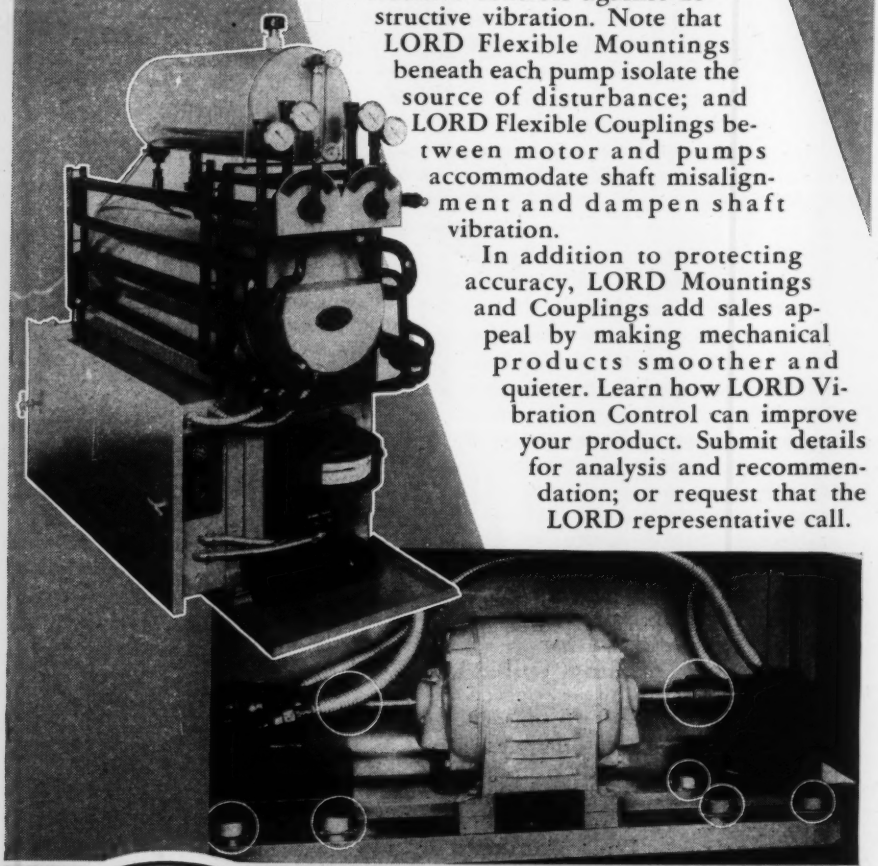
RIVITORS AIR AND HYDRAULIC CYLINDERS CUTTERS CLINCHORS

Protected with LORD BONDED RUBBER PRECISION! Mountings and Flexible Couplings

Precision of temperature control is the basis for uniform quality in many products. Typical of the equipment which automatically maintains process temperatures within close limits under varying load conditions is the Royle Temperature Control Unit shown here!

It is also typical of modern equipment design that LORD products are used to protect sensitive controls against destructive vibration. Note that LORD Flexible Mountings beneath each pump isolate the source of disturbance; and LORD Flexible Couplings between motor and pumps accommodate shaft misalignment and dampen shaft vibration.

In addition to protecting accuracy, LORD Mountings and Couplings add sales appeal by making mechanical products smoother and quieter. Learn how LORD Vibration Control can improve your product. Submit details for analysis and recommendation; or request that the LORD representative call.



LORD BONDED RUBBER Vibration-Control Mountings . . . Bonded-Rubber Parts

LORD MANUFACTURING COMPANY ERIE, PA.

Canadian Representative: Railway & Power Engineering Corp. Ltd.

NEW MACHINES

And the Companies Behind Them

Heating and Ventilating

ROOM AIR COOLER: Direct-drive dual-blower air cooler for small areas. Capacity, 320 cfm with air velocity of 1500 fpm. For window use; dimensions, 15 by 21 by 12 in. Self-contained unit includes built-in pump and adjustable air-deflection grilles. Trough type water drip system permits thorough pad coverage and efficient cooling. Water reservoir capacity, 4 1/3 gal; weight, 35 lb. *Palmer Manufacturing Corp., Phoenix, Ariz.*

COMPRESSORS: Reciprocating compressors for air conditioning applications. In 10, 15, 20, 25, 40, and 50-ton capacities, with complete condensing units for each size. Include "V" and "W" arrangements of 4, 6 and 8-cylinder models; counterbalancing of all reciprocating forces for vibrationless operation; static and dynamic balancing of crankshaft; and aluminum pistons and connecting rods to reduce moving weight. Noise reduced through use of plastic-cushioned valves and special suction and discharge gas passages. Units have unloaded starting and automatic internal capacity control governed by cooling demand. *The Trane Co., La Crosse, Wis.*

Manufacturing

PUNCH PRESS: Capacity, 4 tons. New press has 12¾-in. throat, 400-lb cast frame and clutch drive dog built into clutch collar instead of slot in crankshaft. Trip mechanism permits operator to change from single to continuous ramming without stopping press. Adjustable bed converts from standard press to long punch, half or horn press. *Kenco Manufacturing Co., Los Angeles, Calif.*

PLASTIC WELDER: For sealing and fabrication of plastics without external heat. Model 112 Ectrotherm radio-frequency generator provides 4000 to 5000 watts plate input power, depending on duty cycle, for processing flexible film, rigid sheet, tubing and rod forms of vinyl, acetate, Nylon, polyethylene, and others. Power is adequate to single-shot weld seams 40 in. long or complex seams covering extensive areas. Air-operated presses available in 2 and 3-post types to handle

Century 1/8 TO 3/4 H. P. MOTORS

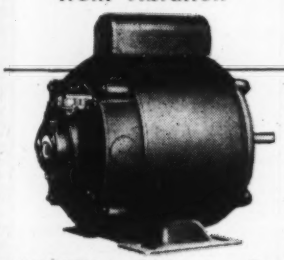
Choose From These Many Types to Fit Your Job

HEAVY-DUTY for Industrial and Appliance Use

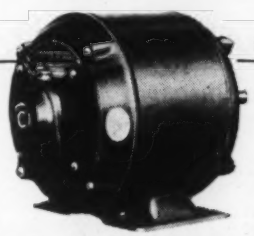
From Century's wide range of types and sizes, there's a proper motor for all popular applications. You can be confident that the right Century motor will assure a long life of satisfactory performance.

Shown here are examples of Century's line of FRACTIONAL HORSEPOWER motors—ruggedly built for smooth, quiet operation, with a remarkable freedom from vibration

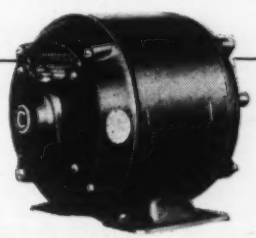
Century Electric Company is celebrating its 50th year in the electrical industry.



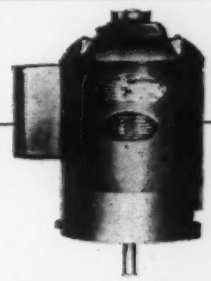
TYPE CSH — Capacitor Start Induction Single Phase Motor suitable where high starting torque and normal starting current is satisfactory.



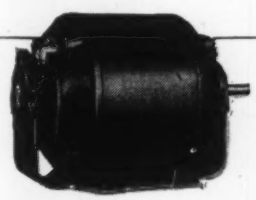
TYPE SP — Split Phase Induction, Rigid Base, Single Phase Motors suitable for light starting duty.



TYPE SC — Squirrel Cage Polyphase Motor built in fractional sizes for all torque requirements.

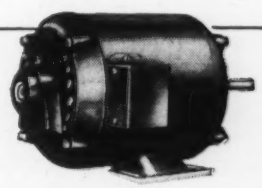


JET PUMP MOTOR—Capacitor Start Single Phase Motor available in sizes for practically every jet pump application.

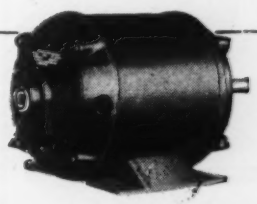


TYPE SP — Split Phase Induction, Cushion Base, for quiet operation.

OIL BURNER MOTOR especially designed for this service. Compact, rugged; smooth, quiet starting and running.

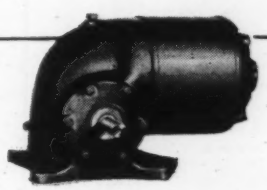


TYPE RS — Repulsion Start Induction Single Phase Brush Lifting Motor suitable for applications requiring high starting torque and low starting current.



TYPE DM — Direct Current built in sizes and ratings for applications where direct current is available or its use desirable.

UNIT HEATER MOTOR provides smooth, quiet performance throughout a long service life.



GEAR MOTOR, compact, rugged, ball bearing equipped, for your high torque, slow speed requirements.

The complete line of Century motors includes a wide range of types and kinds, from 1/8 to 400 horsepower. They are available in open rated, splash proof, totally enclosed fan cooled and explosion proof frames.

Specify Century motors for all your electric power requirements.

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St. Louis 3, Missouri

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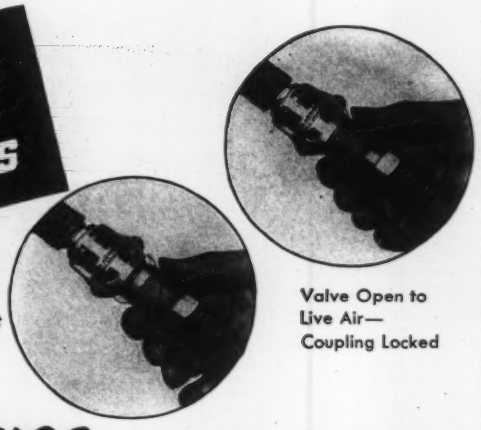
OFFICES AND STOCK POINTS IN PRINCIPAL CITIES

Quick-As-Wink AIR AND HYDRAULIC Control Valves



Valve Closed to Live Air— Open to Exhaust

Valve Open to Live Air— Coupling Locked

VALVE COUPLINGS ¼", ⅜", ½", & ¾" SIZES

For Economy and Safety

● These couplings permit air to be shut off and tools changed quickly without going to the main shut-off valve. Coupling jaws are automatically self-locking when valve is open to air supply. The coupling cannot be disconnected until the valve sleeve is moved to closed and exhaust position,— thus preventing accidents and injuries. Pressures to 250 p.s.i.—hose shank, male or female pipe connections. *Send for Bulletin No. 104-C. It gives full details and prices.*

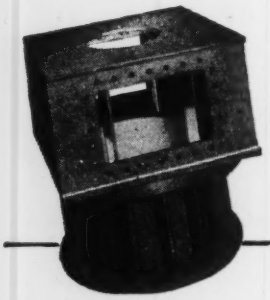
THE HIGHER THE PRESSURE THE TIGHTER THE SEAL

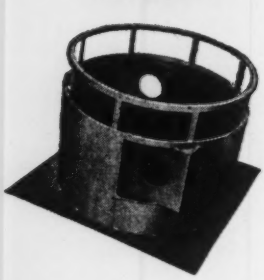
Quick-As-Wink AIR AND HYDRAULIC Control Valves

Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

Mfd. by C. B. HUNT & SON, INC., 1946 East Pershing St., Salem, Ohio

Weldments by Littleford





EXPERIENCE IS YOUR ASSURANCE OF QUALITY WORK AT A LOW COST

Design Engineers have found Littleford's experience in shearing, flame cutting, punching, bending, rolling and welding plate and sheet metals a great boon in developing new products. Fabricated Weldments by Littleford have found a place in almost every industry. Engineers know too that Littleford fabricates with unerring precision and assumes a definite responsibility for the quality of the finished product. If you have a Weldment problem and want this Littleford experience and "know how" to work for you, send blueprints for an estimate of cost or write for the Bulletin on Littleford Weldments.

FABRICATORS OF PLATE AND SHEET METALS

LITTLEFORD

LITTLEFORD BROS., INC.
424 E. Pearl Street, Cincinnati 2, Ohio

electrodes for both types of weld. *Electronic Process Corp., San Jose, Calif.*

BURNISHER: Pivot polishing machine for wet polishing of small parts to 600 parts per hour. Max diameter to be polished, 0.197-in.; minimum diameter, 0.008-in.; max length to be polished, 0.315-in.; max length of workpiece, 5 in. Burnishing done by special carbide or ceramic wheels. *Hauser Machine Tool Corp., Manhasset, N. Y.*

ELECTRIC HAND DRILL: For general utility work in industrial plants. Model S2 ¼-in. drill has 1600-rpm free speed, power consumption of 180 watts, d-c or a-c up to 70 cycles. Weight, 2½ lb. Shielded ventilation system insures cool running. Balanced, vacuum-impregnated armature carried in preloaded self-aligning ball bearings. *Newage International Inc., New York, N. Y.*

SHRINK FINISHING MACHINE: Removes wrinkles from parts formed on rubber pad presses. Mechanically driven lead "slapper" strikes series of blows along wrinkled edge of workpiece. Slapper conforms to shape of work after first few blows. Pneumatic clamp holds part and form block to table during working. Form block and workpiece rotate to cover entire perimeter. *Hufford Machine Works Inc., Redondo Beach, Calif.*

MILLING ATTACHMENT: Heavy-duty Universal spiral milling attachment for milling requiring cutter spindle adjustment to any angle in horizontal or vertical planes. Driven from machine spindle. Has 360-degree swivel range in two planes, with primary bracket clamped to face of column and to front end of overarm. Spindle and all shafts mounted on antifriction bearings. *Cincinnati Milling and Grinding Machines Inc., Cincinnati, O.*

GRID WINDING LATHE: Brimar grid lathe for winding vacuum tube grids. Produces more turns per inch than formely possible, simplifies servicing and reduces maintenance to minimum. Provides sure method of strip-cutting to eliminate spring-back of support wires when cut, thereby increasing accuracy of grid lengths. Possible to wind to final profile, hot-stretch strip after winding to straighten support wires, and to burn out loose turns between grids during winding. *International Standard Trading Corp., New York, N. Y.*

ELECTRIC HAMMER AND DRILL: Combination portable tool for drilling

concrete, drilling metal and wood, or driving grinding, buffing and wire wheels. Weight of complete unit, 15 lb. Drill capacity, ⅜-in. drill size; drills 9/16-in. diameter at 3½ in. per minute in concrete. Drilling range of hammer, ¼ to 1⅜ in. Hammer assembly detaches from drill unit. *Wodack Electric Tool Corp., Chicago, Ill.*

RIVET GUN: For setting explosive type rivets. Does not require close hole tolerance for setting explosive rivets. Average time per rivet, less than two seconds. For blind riveting and all conventional jobs, does not require bucking bar. Weight of gun with tip, 2 lb.; weight of transformer with cable and air hose, 34 lb. Includes two-piece molded phenolic handle, two-piece cast aluminum bus bar with air ducts for cooling, tips and transformer. *Ripley Co. Inc., New York, N. Y.*

BENCH CRANK PRESS: For stamping name plates and other small parts, eliminating use of power press. Ram head takes type holders, numbering heads and special dies. Available in three styles; Model 131 operated by hand lever; Model 132 operated by 3-in. air cylinder and controlled by 4-way valve; Model 133 operated by motor through eccentric having releasing device controlled by lever. Dimensions, 16 by 10 by 15 in.; throat depth, 6 in.; clearance between ram and table when adjusted down, 3¾ in. Weight, 125 lb. *Numberall Stamp & Tool Co., Staten Island, N. Y.*

BAG MAKING MACHINE: Model 4S makes satchel-bottom bags from 7½-in. wide by 10.68-in. tube length by 2⅝-in. bottom width up to max of 17 in. wide by 28.58-in. tube length by 6-in. bottom width. Includes new 3-station drum for increased speed, rotary cutoff that reduces noise level of machine, and adjustable formers to vary sack width instead of individual formers. Trade mark imprinter and 2-hole punch and scorer available as accessories. *Potdevin Machine Co., Brooklyn, N. Y.*

POWER SHEAR: For full capacity shearing at from 30 to 200 rpm. Speed of shearing stroke for continuous or single-cycle operation positively controlled with speed-control handle. Nonrepeating safety clutch provides for single-stroke operation. *O'Neil-Irwin Manufacturing Co., Lake City, Minn.*

HAND-WELDING EQUIPMENT: Hand torch and automatic wire drive unit for argon metal arc welding. Consumable electrode serves as

Quick-As-Wink
AIR AND HYDRAULIC
Control Valves

No. 1551-N3
¾ Inch Neutral Position 3-Way Air Valve

HAND OPERATED Air Valves

Thousands of Uses Throughout Industry

● Universally used and endorsed. Valving mechanism has stainless steel body and push-pull rods, brass sleeves, self-sealing U-packers and many other refinements, all fully enclosed against dirt, assuring long efficient trouble-free operation. No metal to metal seating. ⅜" to 1½" sizes, 3-way and 4-way, neutral position and regular actions. Pipe header mounting plates furnished if desired. *Write for full details.*

THE HIGHER THE PRESSURE THE TIGHTER THE SEAL

Quick-As-Wink
AIR AND HYDRAULIC
Control Valves

Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

Mfd. by C. B. HUNT & SON, INC., 1948 East Pershing St., Salem, Ohio

Timing Circuits Simplified!
Beyond the shadow of a doubt!

EAGLE MICROFLEX
RESET TIMER

2 Load Switches available, each adjustable for 7 different actions!

You can work wonders with the Microflex Timer and its more than 100 possible operating combinations. There is no need for additional relays. Investigate the timer that does the complete job!

When Accuracy Counts

EAGLE SIGNAL
CORPORATION
Moline, Illinois

Write For
BULLETIN 110

"CIGAR, MARY?"

Just because Joe enjoys a good stogie, he shouldn't assume Mary enjoys one, too!

And just because one bearing is best lubricated by one particular grade of oil, you shouldn't assume that the same oil is best for *all* bearings on that machine. In many cases it isn't.

OIL CUPS permit you to lubricate each bearing with the oil best suited to that bearing—thus prolonging bearing life, reducing maintenance costs, cutting down-time, boosting production. And oil cups fortunately *cost very little.*

Gits oil cups have been the standard for industry for more than 40 years. Gits Bros. has the largest selection of oil cups available anywhere. Call on Gits Bros. for a prompt, efficient solution to your lubrication problems.

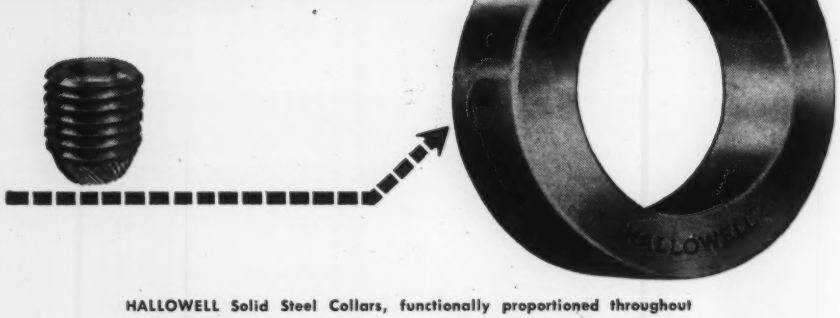
Write for free Price Guide Catalog

GITS BROS. MFG. CO.

1868 S. Kilbourn Ave. • Chicago 23, Ill.

HALLOWELL

Steel Collars



HALLOWELL Solid Steel Collars, functionally proportioned throughout . . . precision-machined so faces run perfectly true . . . are beautifully polished all over . . . yet they cost less than common cast iron collars. 3" bore and smaller are made from Solid Bar Stock. To make sure the collar won't shift on the shaft, they are fitted with the famous UNBRAKO Knurled Point Self-Locking Socket Set Screw—the set screw that won't shake loose when once tightened. HALLOWELL . . . a "buy word" in shaft collars . . . available in a full range of sizes for

IMMEDIATE DELIVERY

Write for name and address of your nearest HALLOWELL and UNBRAKO Industrial Distributors.

OVER 48 YEARS IN BUSINESS

SPS STANDARD PRESSED STEEL CO.

JENKINTOWN 18, PENNSYLVANIA

filler metal, with rod fed fro coil into argon-protected atmo phere at steady rate. Particular adaptable to welding aluminum i ranges of thickness from ⅛ to 1 in. Rod feed, argon flow and coo ing water automatically controlle electronic governor gives accurat and uniform control of rate o rod feed between 80 and 380 i per minute. *The Linde Air Pro ucts Co., New York, N. Y.*

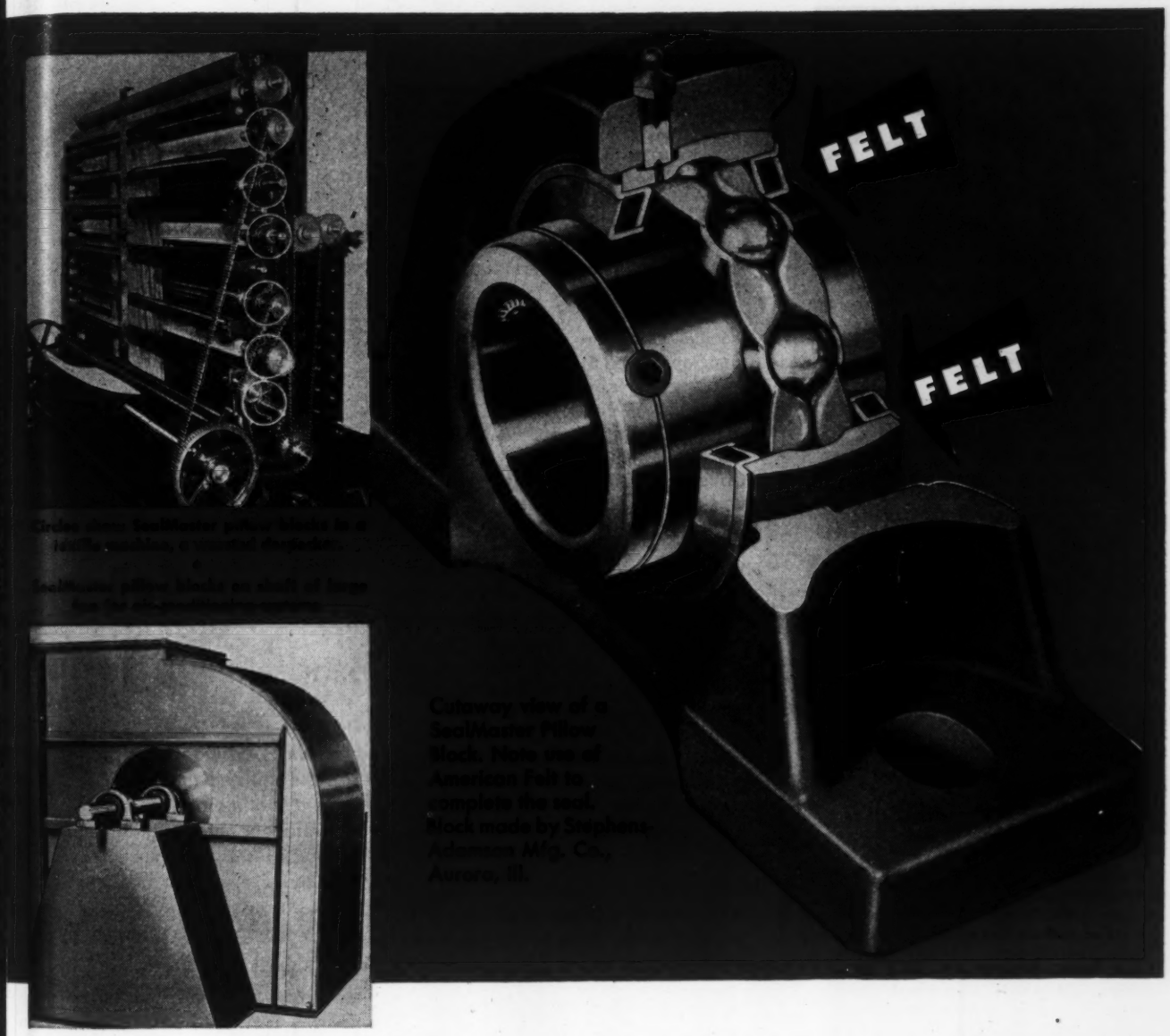
SURFACE GRINDER: For grindin blocks, dies or other parts or uni to 12 in. high. Model MG grinde utilizes Meehanite castings for im proved rigidity. Grinding accurac up to 0.0002-in. possible, even a extreme positions. Uses Vee typ ground and lapped slides. Travers movement, 8¾ in.; longitudina movement, 13 in.; vertical move ment, 12 in. Equipment include dynamically-balanced 110/220-vo motor, controls, wheel adapter, dus guards, exhaust guards, and grind ing wheel. *Sanford Manufactur ing Co., Union, N. J.*

SANDBLAST CABINET: For cleaning dies, tools, pistons, piston rings and other small parts with soft abrasives such as ground corn cobs or nut shells. Also can be used with sand or metal abrasives. Ca binet includes two light fixtures for illuminating interior, exhaust fan, dust bag, and two rubber arm sleeves. Bench area, 14 by 17 in. Requires connection to compressed air and 110-v power lines. *The W. W. Sly Manufacturing Co., Cleve land, O.*

SEAM WELDER: Automatic hidden-arc seam welder for metal ranging from 14 gage to ¼-in. thick. De signed for welding cylinders or other hollow shapes, such as heat er shells and through-welding flanges in making containers. Han dles work to 18 ft long; minimum diameter is 12 in. Universal horn type machine uses Lincolnweld head and carriage. *Cecil C. Peck Co., Cleveland, O.*

BENDING MACHINE: Hydraulic Model 800 bending machine with capacity of 1¼-in. OD #16 B.W.G. steel tubing. Dimensions, 21 by 78 by 34 in. Powered by standard 2-hp, 220/440-v, 3-phase, 60-cycle motor furnished with machine. Operated by single lever. Bending die held in by spring clips for easy chang ing; combination die has four dif ferent sizes, one on each side. *Wal lace Supplies Manufacturing Co., Chicago, Ill.*

PORTABLE POWER SAW: Reciprocating blade saw fits any heavy-duty ½



Cutaway view of a SealMaster Pillow Block. Note use of American Felt to complete the seal. Block made by Stephens-Adamson Mfg. Co., Aurora, Ill.

Let's LOOK INTO the Use of FELT by SEALMASTER

• Here is an exceptionally interesting example of the use of American Felt in a bearing seal. Note that the seal consists of an inner labyrinth ring pressed into the outer race of the bearing, an outer flinger ring pressed onto the inner race of the bearing, and a ring of felt in the channel between the two. The felt rotates with the outer ring, and as it is assembled without pressure, there is no danger of glazing or wear.

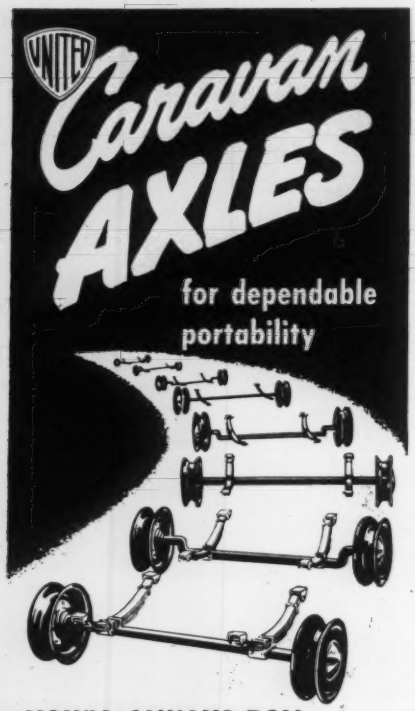
Now let's see what happens in service. Due to the rotation of the outer steel ring and the felt ring, a centrifugal action is developed. Three effects result from this action in combination with the design of the labyrinth: 1, entry of dirt into the seal is prevented; 2, excess grease that may work its way past the vortex or trap created by the steel seal ring on the outer race passes slowly through the felt; 3, the felt is kept clean and free from glazing. When rotation stops there are still the same barriers, except the centrifugal. No wonder these pillow blocks run for years with such protection!

• American provides various types of felt, plain or laminated with impervious materials, to meet the need for reliable seals. Write for authoritative Data Sheet No. 11, "Felt Seals, Their Design and Application", complete with illustrative samples.

American Felt Company

TRADE MARK

GENERAL OFFICES: 22 GLENVILLE RD., GLENVILLE, CONN. ENGINEERING AND RESEARCH LABORATORIES: GLENVILLE, CONN. —PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal.



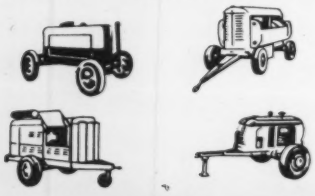
YOU'LL ALWAYS ROLL WITH "CARAVAN"

CARAVAN units increase operating efficiency, reduce axle costs, and provide dependable movability for all types of portable equipment. These durable axles are recommended for military and industrial as well as field-service and construction equipment such as concrete mixers, welding apparatus, drilling rigs, etc.

Available in two-wheel, single-axle units as well as four-wheel automotive type running-gear, CARAVAN units are furnished in straight and drop types. CARAVAN four-wheel axles employ controlled camber, toe-in and caster, which facilitate positive trail at high speeds or over rough terrain. Axle beam construction is of solid square steel stock, and sized to individual specifications.

Featuring load capacities from 1,000 to more than 12,000 pounds, CARAVAN axles are available in a wide range of sizes and models to meet all requirements.

Multicolored, 12-page, illustrated Catalog No. 101 describes complete line of CARAVAN axles as well as CARAVAN surge-control braking device and CARAVAN retractable third-wheel for use on two-wheel, single-axle units. Catalog includes photographs, line drawings and complete specifications. Write today for your copy.



THE UNITED MFG. COMPANY

314 W. INTERSTATE ST. • BEDFORD, OHIO

or 5/16-in. drill, compressed air or flexible shaft equipment. Designed for continuous duty; requires no starting hole. Built-in blower keeps saw cool. Special-purpose blades available. *R.C.S. Tool Sales Corp., Joliet, Ill.*

ARC WELDER: Special 300-amp gas driven arc welder with 3-kw auxiliary power generator. Designed for field repair and maintenance work. Self-contained unit powered by 6-cylinder, 4-cycle, 1500-rpm, water-cooled Chrysler industrial engine developing 53.5 hp, connected to welding generator by flexible coupling. Welding generator rated 40-v, 300-amp, with cooling supplied by squirrel-cage type fan. Auxiliary generator supplies power for lights and power tools. *Hobart Brothers Co., Troy, O.*

EXTRUSION TAKEUP: Constant-tension, dual - reel, continuous - extrusion takeup with integral capstan and tension stand for plastic or rubber-coated wire, cord or cable. Speed range of takeup, 0 to 2600 fpm. Empty reel accelerated to synchronous wire speed as soon as cross-over is made, with no interruption in winding process. All drives are hydraulic; traverse provides 25 to 1 lay range. *Industrial Ovens Inc., Cleveland, O.*

MASH WELDING MACHINE: For resistance mash welding flat sheets of pickled mild steel to 28-in. width in thicknesses from 0.020 plus 0.020-in., minimum to 0.080 plus 0.080-in., max. Locating and clamping table automatically locates sheets to proper overlap and holds them for welding operation. Two steel idling wheels then roll overlap to minimum thickness, controlled by pressure of upper head assembly. Designed to provide continuous strip for mill operations. *Sciaky Bros. Inc., Chicago, Ill.*

Materials Handling

HAND TRUCK: Employs aluminum single-unit oil tank and pump combination to raise loads 25 per cent easier and 25 per cent faster than previous models. Hydraulic fluid contained in unit above dual pumps, circulates by gravity into pumps. Truck raises and lowers with same lifting handle. Double ball-bearing fifth wheel allows operator to steer easily with any handle position. *Market Forge Co., Everett, Mass.*

COTTON TRUCK: Three-in-one unit includes interchangeable bale stacker, hydraulic bale clamp or standard forks for use with LT-40 fork lift truck. Designed for easy maneuvering in box cars and congest-

AS THE Goddess of Liberty

symbolizes the independence of America and the uplifted torch indicates enlightenment to the world, the sole mission of this independent ball plant is to produce precision balls of unexcelled surface finish and accuracy for bearing manufacturers and users. We do not make bearings, we manufacture balls only.

Universal Balls are manufactured in new plant, under ideal working conditions, with modern equipment. We invite you to inspect our facilities and personally verify this fact. Bearing balls of uniform quality and extremely fine tolerances are the result of fine equipment and utmost operational care. The art of making balls to within ten millionths of an inch is the outcome of long years of study and scientific research.

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WILLOW GROVE, Montgomery County, Pa.
Telephone, Willow Grove 1200

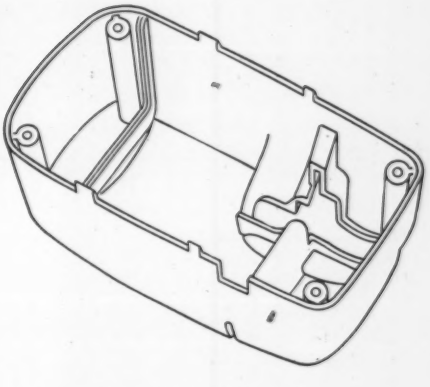
Housing molded with Hercules Cellulose Acetate Molding Powder by Industrial Plastics Company, Chicago, Illinois.*

a double edge— IN SELLING, TOO!

HERE is something really new in kitchen tools—the Oster electric knife sharpener. Simple and easy to use, its unique double action quickly puts a factory-sharp edge on any knife, sharpening both sides of the blade at the same time.

In turn, a gleaming-white housing molded with versatile cellulose acetate gives this new Oster product a double selling edge. It *looks* better, and *works* better, too! Handsomely styled, its through-and-through color can't chip, peel, or wear off . . . it has excellent resistance to kitchen oils and greases . . . plus a hard-to-break toughness that spells a long and satisfactory service life.

Whether yours is a household or an industrial product, you may find in cellulose acetate an excellent means of giving it an edge on the competition, both in appearance and performance. Our design and technical staffs invite your inquiries.



A skillfully constructed die produced this sturdy housing with complex contours and narrow knife blade slots. In addition to other properties obtained, cellulose acetate provided a material which would not resonate under vibration—insuring quiet operation of the completed unit.

HERCULES POWDER COMPANY INCORPORATED *950 King St., Wilmington, Del.*

HERCULES Cellulosic Plastics

*TRADE-MARK

Inquiries about the new Oster electric knife sharpener should be addressed to the manufacturer, John Oster Mfg. Co., Racine, Wisc. CP51-3

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printing frames—
vacuum-back
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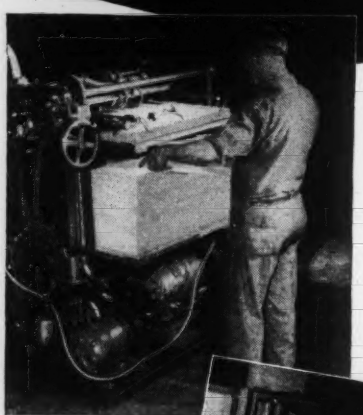

Like American Type Founders, you may gain real advantages by specifying Gast Rotaries as components of your products.

Consider this record: For 10 years, ATF has used Gast Air Pumps on their Vacuum-back Cameras and Printing Frames.

The result? Gast dependability and performance proved itself. Now ATF is using Gast Air Pumps on many Kelly-One and Little Giant Presses. In the graphic arts industry — and in many other fields — the trend to Gast continues.

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AIR MOTORS · COMPRESSORS · VACUUM PUMPS
(TO THREE H.P.) (TO 30 LBS.) (TO 28 INCHES)
GAST MANUFACTURING CORP., Hinkley St., Benton Harbor, Mich.

ed areas and for rapid stacking and "breaking out". *Towmotor Corp., Cleveland, O.*

BOX CAR LOADER: Portable, telescoping-bed, power-belt conveyor designed to move bags, cartons, bales, etc., into box cars. Loader first positioned under end of supply chute with lower bed extended to flow goods to end of car. Lower bed retracts as car fills. *The Rapids-Standard Co. Inc., Grand Rapids, Mich.*

ELECTRIC HOISTS: New line in capacities from 250 to 1000 lb. Uses shorter, deeper drum; hoists are lighter and better balanced than previous models. Units use two parts of 3/16-in. Trulay cable, are ideal for hook suspension. *Wright Hoist Div., American Chain & Cable Co. Inc., Bridgeport, Conn.*

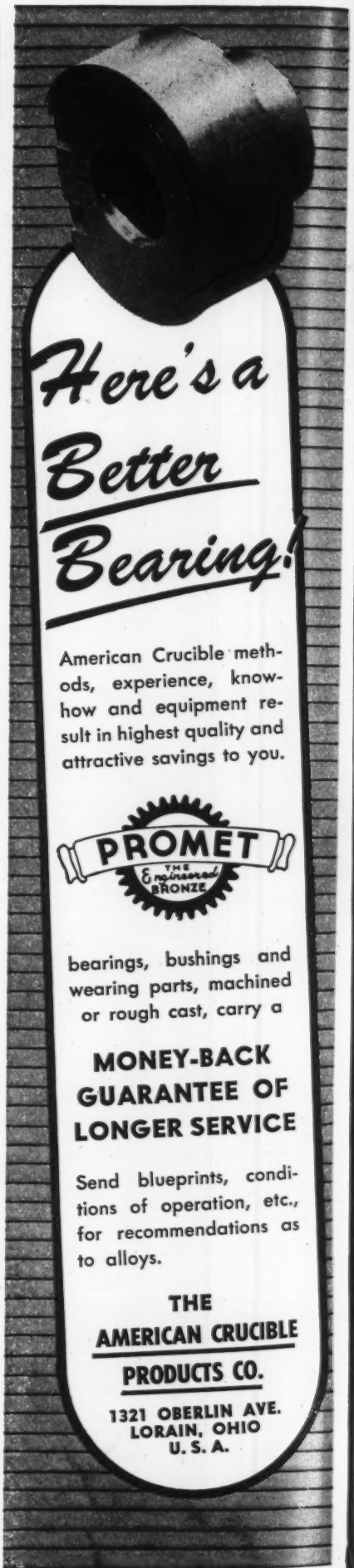
LIFT TRUCK: Telescoping uprights are low enough to enter motor truck van body but will tier materials three pallets high. Overall height with mast lowered, 72 in.; height with mast extended, 142 in.; max lift from floor to forks, 117 in. Roller chain lift mechanism allows clear view between uprights. Lift speed, 45 fpm. Drive controls allow forward or reverse motion at push or pull of single lever. Tier-Master truck is stand-up type, 2000-lb capacity unit with outside turning radius of 57 in. Powered by 3-cylinder, air-cooled gas engine. *Mobilift Corp., Portland, Oreg.*

DRUM CLAMP: For handling of cylindrical objects individually or as unit loads on pallets. Two rubber-faced grab plates attach to forks of lift truck. Forks are moved in or out by separate hydraulic cylinders from 32-in. to 19-in. inside spacing. Grab plates are removed when moving loaded pallets. *Baker Industrial Truck Div., The Baker Raulang Co., Cleveland, O.*

FORK TRUCK: Redesigned Pil-Pac for handling unit loads without use of conventional pallets. Pantograph type linkage actuates gripper jaw and pusher rack to pull load back onto wide, thin forks used instead of pallets. Unit has detachable mounting, is interchangeable with standard forks up to 54-in. usable length. *Industrial Truck Div., Clark Equipment Co., Battle Creek, Mich.*

Plant Equipment

TANK TYPE CLEANER: For industrial and commercial use. Combination 3-in-1 unit includes vacuum cleaner, water pickup, and hand cleaner or blower. Includes 12-gal rust-resistant tank set on casters, motor and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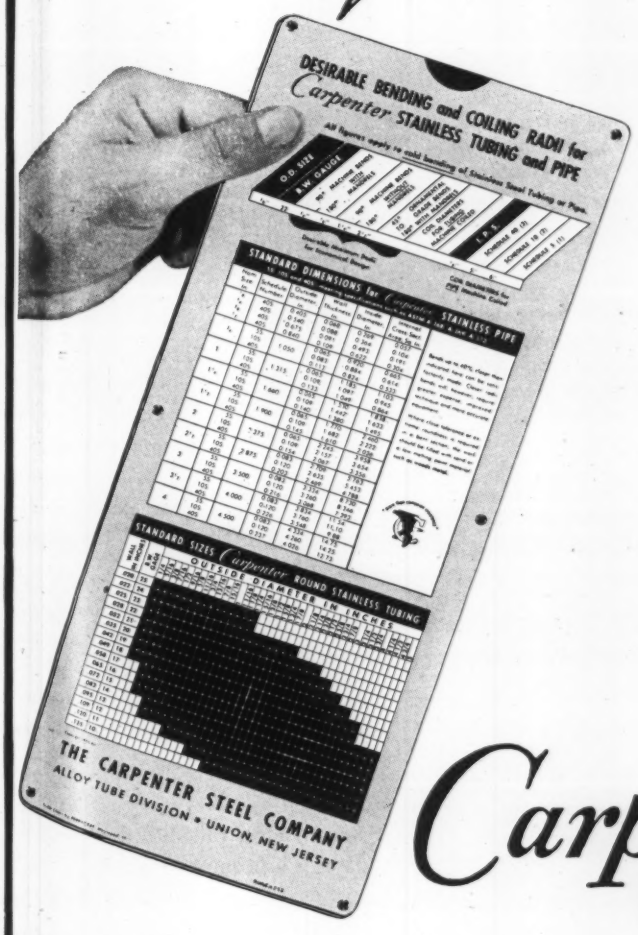
New *Carpenter* Slide Chart contains useful data on STAINLESS TUBING and PIPE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Individual operation of 13 flue dampers, in a smoke filter system, is provided by 13, 2" diam. x 6" stroke Ledeen Heavy Duty Cylinders. Dampers divert smelter smoke through bag filters, to remove metallic content, as part of a smoke abatement program.

System is automatic, controlled by a central timer on a planned cycle. 100 P.S.I. plant air supply operates each cylinder on impulse from the timer. Manual operation is completely eliminated.

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fan assembly and spraying attachment. In heavy-duty, 1 1/3-hp and medium-duty, 2/3-hp models. *Ideal Industries Inc., Sycamore, Ill.*

AIR COMPRESSOR: Portable Gyro-Flow 600 compressor delivers 600 cfm free air at 100 psi. Weight, 9500 lb mounted on 4-wheel trailer. Compressor is two-stage, oil-cooled, rotating-vane type which eliminates pistons, rods, valves and clutch. Air discharges at less than 200 F under normal conditions. Driven by GM series 71, 6-cylinder, 2-cycle, uniflow-scavenging diesel engine equipped with 12-v battery starting. Capacity control combines variable intake unloading with engine speed control to hold pressure steady. Compressor smoothly controlled over 0 to 100 per cent capacity range. *Ingersoll-Rand Co., New York, N. Y.*

PORTABLE ELECTRIC HAMMER: Power unit consists of two alternately energized magnetic coils, eliminating gears, cranks and connecting rods. For drilling and channeling in concrete, vibrating concrete forms, chipping, etc. Max operating range of 1⅛-in. hammer is from ⅜ to 1½-in. diameter star drills. Hammer strikes 3600 blows per minute, measures 16¼ in. long, weighs 20 lb. Line of accessories available. *Skilsaw Inc., Chicago, Ill.*

STEAM CLEANER: All electric unit requires 14 by 18-in. floor space, weighs less than 100 lb. Equipped with 8-in. rubber-tired wheels. Uses steam from built-in high-pressure boiler designed to operate on 220-v, single-phase, adaptable to 115-v, or on 220/440/550-v, three-phase current. *Livingston Engineering Co., Worcester, Mass.*

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TRANSFORMERS: Hermetically - sealed dry type transformers with Class B insulation. Priced only 10 per cent over conventional open type units. Can be operated satisfactorily in nitrogen atmosphere at 180 C. Ratings through 1500 kva and 15,000 volts. Can be equipped with GE metal-clad switchgear for load center installations or with network protector and high-voltage switch as completely equipped network unit. Transformers are nitrogen filled. *Transformer and Allied Products Div., General Electric Co., Schenectady, N. Y.*

Testing and Inspection

VACUUM TEST CHAMBER: For testing component parts at vacuums corresponding to altitudes to 60,000 ft. Chamber is held at any desired

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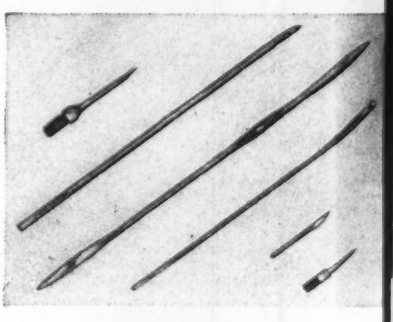

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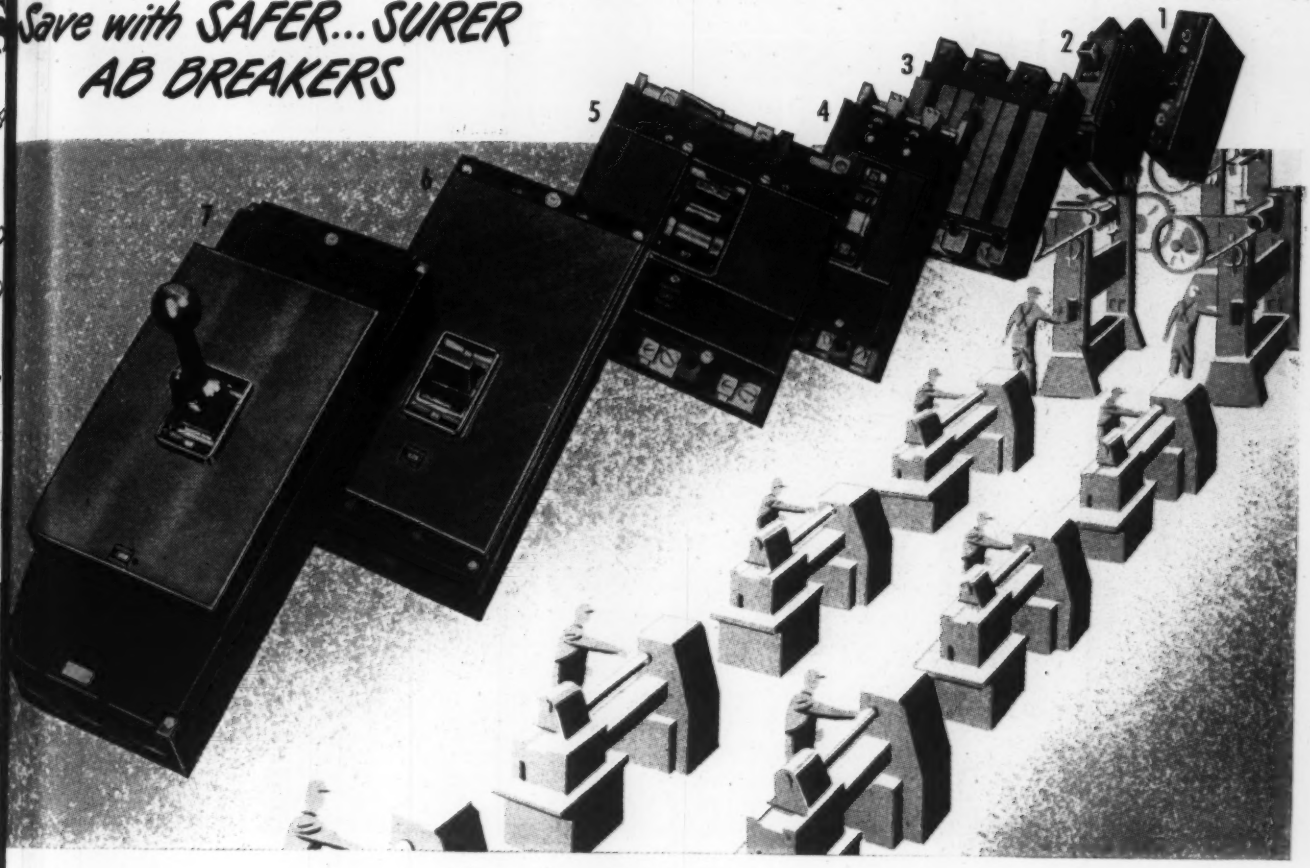

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Power outages are doubly punishing when production lines are loaded. Today, lost production means longer deliveries; idle men and machines add to already fast rising costs.

Westinghouse Circuit Breakers help you minimize down time, and offer you completely reliable control and protection for every lighting and power requirement and for circuits that serve them. Westinghouse Breakers trip instantly on short circuits, yet ride out temporary, harmless peaks. And to get you off to a flying start again when trouble on the circuit is cleared, simply flip the breaker handle. No replacements, no chasing after fuses, no costly maintenance time in restoring power.

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4. **F FRAME**—2 or 3 pole; thermal-magnetic trip type; 10-100 amperes.
5. **G FRAME**—2 or 3 pole; particularly adapted to severe operating conditions in heavy industry; 40-100 amperes.
6. **K FRAME**—2 or 3 pole; universal service power breaker; 70-225 amperes.
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